THE

POPULAR SCIENCE MONTHLY.

APRIL, 1881.

THE DEVELOPMENT OF POLITICAL INSTITUTIONS.

By HERBERT SPENCER.

VI.—POLITICAL HEADS—CHIEFS, KINGS, ETC.

OF the three components of the triune political structure traceable at the outset, we have now to follow the development of the first. Already in the last two chapters something has been said, and more has been implied, respecting that most important differentiation which results in the establishment of a headship. What was there indicated under its general aspects has here to be elaborated under its special aspects.

"When Rink asked the Nicobarians who among them was the chief, they replied, laughing, how could he believe that *one* could have power against so many?" I quote this as a reminder that there is at first resistance to the assumption of supremacy by one member of a group—a resistance which, though in some types of men small, is in most considerable, and in a few very great. To instances already given of tribes practically chief-less, may be added, from America, the Haidahs, among whom "the people seemed all equal"; the Californian tribes, among whom "each individual does as he likes"; the Navajos, among whom "each is sovereign in his own right as a warrior"; and from Asia the Angamies, who "have no recognized head or chief, although they elect a spokesman, who, to all intents and purposes, is powerless and irresponsible."

Such small subordination as rude groups show occurs only when the need for joint action is imperative, and control is required to make it efficient. Instead of recalling before-named examples of temporary chieftainship, I may here give a few others. Of the Lower Californians we read, "In hunting and war they have one or more chiefs to lead them, who are selected only for the occasion." Of the Flatheads'

chiefs it is said that "with the war their power ceases." Among the Sound Indians the chief "has no authority, and only directs the movements of his band in warlike incursions."

As observed under another head, this primitive insubordination has greater or less play according as the environment and the habits of life hinder or favor coercion. The Lower Californians, above instanced as chief-less, Baegert says resemble "herds of wild swine, which run about according to their own liking, being together to-day and scattered to-morrow, till they meet again by accident at some future time." "The chief among the Chipewyans are now totally without power," says Franklin; and these people exist as small migratory bands. Of the Abipones, who are "impatient of agriculture and a fixed home," and "are continually moving from place to place," Dobrizhoffer writes, "they neither revere their cacique as a master, nor pay him tribute or attendance as is usual with other nations." The like holds under like conditions with other races remote in type. Of the Bedouins Burckhardt remarks, "The sheik has no fixed authority"; and, according to another writer, "A chief who has drawn the bond of allegiance too tight is deposed or abandoned, and becomes a mere member of a tribe, or remains without one."

And now, having noted the original absence of political control, the resistance it meets with, and the circumstances which facilitate evasion of it, we may ask, What causes aid its growth? There are several; and chieftainship becomes settled in proportion as they cooperate.

Among the members of the primitive group, slightly unlike in various ways and degrees, there is sure to be some one who has a recognized superiority. This superiority may be of several kinds, which we will briefly glance at.

Though in a sense abnormal, the cases must be noted in which the superiority is that of an alien immigrant. The head-men of the Khonds "are usually descended from some daring adventurer" of Hindoo blood. Forsyth remarks the like of "most of the chiefs" in the highlands of Central Asia. And the traditions of Bochica among the Chibchas, Amalivaca among the Tamanacs, and Quetzalcoatl among the Mexicans, imply kindred origins of chieftainships. Here, however, we are mainly concerned with superiorities arising within the tribe.

The first to be named is that which goes with seniority. Though age, when it brings incapacity, is often among rude peoples treated with such disregard that the old are killed or left to die, yet, so long as capacity remains, the greater experience accompanying age generally insures influence. The chief-less Esquimaux show "deference to seniors and strong men." Burchell says that, over the Bushmen, old men seem to exercise the authority of chiefs to some extent; and

the like is true with the natives of Australia. By the Fuegians "the word of an old man is accepted as law by the young people." Each party of Rock Veddahs "has a head-man, the most energetic senior of the tribe," who divides the honey, etc. Even with sundry peoples more advanced the like holds. The Dyaks in north Borneo "have no established chiefs, but follow the counsels of the old man to whom they are related"; and Edwards says of the ungoverned Caribs, that "to their old men, indeed, they allowed some kind of authority."

Naturally, in rude societies, the strong hand gives predominance. Apart from the influence of age, "bodily strength alone procures distinction among" the Bushmen. The leaders of the Tasmanians were tall and powerful men: "Instead of an elective or hereditary chieftaincy, the place of command was yielded up to the bully of the tribe." A remark of Sturt's implies a like origin of supremacy among the Australians. Similarly in South America. Of people on the Tapajos, Bates tells us that "the foot-marks of the chief could be distinguished from the rest by their great size and the length of the stride." And in Bedouin tribes "the fiercest, the strongest, and the craftiest obtains complete mastery over his fellows." During higher stages physical vigor long continues to be an all-important qualification; as in Homeric Greece, where even age did not compensate for decline of strength: "an old chief, such as Peleus and Laertes, can not retain his position." And throughout mediæval Europe maintenance of headship largely depended on bodily prowess.

Mental superiority, alone or joined with other attributes, is a common cause of predominance. With the Snake Indians, the chief is no more than "the most confidential person among the warriors." Schoolcraft says of the chief acknowledged by the Creeks, that "he is eminent with the people only for his superior talents and political abilities"; and that over the Comanches "the position of a chief is not hereditary, but the result of his own superior cunning, knowledge, or success in war." A chief of the Coroados is one "who, by his strength, cunning, and courage, had obtained some command over them." And the Ostiaks "pay respect, in the fullest sense of the word, to their chief, if wise and valiant; but this homage is voluntary, and not a prerogative of his position."

Yet another source of governmental power in primitive tribes is largeness of possessions; wealth being at once an indirect mark of superiority and a direct cause of influence. With the Tacullies "any person may become a *miuty*, or chief, who will occasionally provide a village feast." "Among the Tolewas, in Del Norte County, money makes the chief." And, of the chief-less Navajos we read that "every rich man has many dependents, and these dependents are obedient to his will, in peace and in war."

But, naturally, in societies not yet politically developed, acknowledged superiority is ever liable to be competed with or replaced by

superiority arising afresh. "If an Arab, accompanied by his own relations only, has been successful on many predatory excursions against the enemy, he is joined by other friends; and, if his success still continues, he obtains the reputation of being '*lucky*'; and he thus establishes a kind of second, or inferior, agydship in the tribe." So in Sumatra: "A commanding aspect, an insinuating manner, a ready fluency in discourse, and a penetration and sagacity in unraveling the little intricacies of their disputes, are qualities which seldom fail to procure to their possessor respect and influence, sometimes, perhaps, superior to that of an acknowledged chief." And supplantings of kindred kinds occur among the Tongans and the Dyaks.

At the outset, then, what we before distinguished as the principle of efficiency is the sole principle of organization. Such political headship as exists is acquired by one whose fitness asserts itself in the form of greater age, superior prowess, stronger will, wider knowledge, quicker insight, or larger wealth. But, evidently, supremacy which thus depends exclusively on personal attributes is but transitory. It is ever liable to be superseded by the supremacy of some more able man from time to time arising; and, if not superseded, is inevitably ended by death. We have, then, to inquire how permanent chieftainship becomes established. Before doing this, however, we must consider more fully the two kinds of superiority which especially conduce to chieftainship, and their modes of operation.

As bodily vigor is a cause of predominance within the tribe on occasions daily occurring, still more on occasions of war is it, when joined with courage, a cause of predominance. War, therefore, ever tends to make more pronounced any authority of this kind which is incipient. Whatever reluctance other members of the tribe have to recognize the leadership of any one member is likely to be overridden by their desire for safety when recognition of his leadership furthers that safety.

This rise of the strongest and most courageous warrior to power is at first spontaneous, and afterward by agreement more or less definite; sometimes joined with a process of testing. Where, as in Australia, each "is esteemed by the rest only according to his dexterity in throwing or evading a spear," it is inferable that such superior capacity for war as is displayed generates of itself such temporary chieftainship as exists. Where, as among the Comanches, any one who distinguishes himself by taking many "horses or scalps may aspire to the honors of chieftaincy, and is gradually inducted by a tacit popular consent," this natural genesis is clearly shown us. Very commonly, however, there is deliberate choice; as by the Flatheads, among whom, "except by the war-chiefs, no real authority is exercised." By some of the Dyaks, both strength and courage are tested. "The ability to climb up a large pole, well greased, is a necessary qualification of a fighting chief

among the Sea Dyaks"; and St. John says that, in some cases, it was a custom, in order to settle who should be chief, for the rivals to go out in search of a head, the first in finding one being victor.

Moreover, the need for an efficient leader tends ever to reëstablish chieftainship where it is only nominal or feeble. Edwards says of the Caribs that, "in war, experience had taught them that subordination was as requisite as courage; they therefore elected their captains in their general assemblies with great solemnity," and "put their pretensions to the proof with circumstances of outrageous barbarity." Similarly, "although the Abipones neither fear their cacique as a judge, nor honor him as a master, yet his fellow-soldiers follow him as a leader and governor of the war, whenever the enemy is to be attacked or repelled."

These and like facts, of which there are abundance, have three kindred implications. One is that continuity of war conduces to permanence of chieftainship. A second is that, with increase of his influence as successful military head, the chief gains influence as political head. A third is that there is thus initiated a union, maintained through subsequent phases of social evolution, between military supremacy and political supremacy. Not only among the uncivilized Hottentots, Malagasy, and others is the chief or king head of the army—not only among such semi-civilized peoples as the ancient Peruvians and Mexicans do we find the monarch one with the commander-in-chief, but the histories of extinct and surviving nations all over the world exemplify the connection. In Egypt, "in the early ages, the offices of king and general were inseparable." Assyrian records represent the political head as also the conquering soldier; as do the records of the Hebrews. Civil and military supremacy were united among the Homeric Greeks; and in primitive Rome "the general was ordinarily the king himself." That throughout European history it has been so, and partially continues so even now in the more militant societies, needs no showing.

How command of a wider kind follows military command we can not readily see in societies which have no records; we can but infer that, along with increased power of coercion which the successful head warrior gains, naturally goes the exercise of a stronger rule in civil affairs. That this has been so among peoples who have histories there is proof. Of the primitive Germans Sohm remarks that the Roman invasions had one result: "The kingship became united with the leadership (become permanent) of the army, and, as a consequence, raised itself to a *power* [institution] in the state. The military subordination under the king-leader furthered political subordination under the king. . . . Kingship after the invasions is a kingship clothed with supreme rights—a kingship in our sense." In like manner it is observed by Ranke that, during the wars with the English in the fifteenth century, "the French monarchy, while struggling for its very existence, ac-

quired at the same time, and as the result of the struggle, a firmer organization. The expedients adopted to carry on the contest grew, as in other important cases, to national institutions." And modern instances of the relation between successful militancy and the strengthening of political control are furnished by the career of Napoleon and the recent history of the German Empire.

Political headship, then, commonly beginning with the influence gained by the strongest, most courageous, and most astute warrior, becomes established where activity in war gives opportunity for his superiority to show itself and to generate subordination; and thereafter the growth of political power continues primarily related to the exercise of militant functions.

Very erroneous, however, would be the idea formed if no further origin for political headship were named. There is a kind of influence, in some cases operating alone and in other cases coöperating with that above specified, which is all-important. I mean the influence possessed by the medicine-man.

That this arises as early as the other can scarcely be said; since, until the ghost-theory takes shape, there is no origin for it. But, when belief in the spirits of the dead becomes current, the medicine-man, professing ability to control them and inspiring faith in his pretensions, is regarded with a fear which prompts obedience. When we read of the Thlinkeets that "the supreme feat of a conjurer's power is to throw one of his liege spirits into the body of one who refuses to believe in his power, upon which the possessed is taken with swooning and fits," we may imagine the dread he excites and the sway he consequently gains. From some of the lowest races upward we find illustrations. Fitzroy says of the "doctor-wizard among the Fuegians" that he is the most cunning and most deceitful of his tribe, and that he has great influence over his companions. "Though the Tasmanians were free from the despotism of rulers, they were swayed by the counsels, governed by the arts, or terrified by the fears of certain wise men or doctors. These could not only mitigate suffering but inflict it." A chief of the Haidahs "seems to be the principal sorcerer, and indeed to possess little authority save from his connection with the preterhuman powers." The Dakota medicine-men "are the greatest rascals in the tribe, and possess immense influence over the minds of the young, who are brought up in the belief of their supernatural powers. . . . The war-chief who leads the party to war is always one of these medicine-men, and is believed to have the power to guide the party to success, or save it from defeat." Among more advanced peoples in Africa, supposed powers of working supernatural effects similarly give influence, strengthening authority otherwise gained. It is so with the Amazulu: a chief "practices magic on another chief before fighting with him"; and his followers have great confidence in him if he has

much repute as a magician. Hence the power possessed by Langalibalele, who, as Bishop Colenso says, "knows well the composition of that *intelezi* [used for controlling the weather]; and he knows well, too, the war-medicine, i. e., its component parts, being himself a doctor." Still better is seen the governmental influence thus acquired in the case of the king of Obbo, who in time of drought calls his subjects together and explains to them "how much he regrets that their conduct has compelled him to afflict them with unfavorable weather, but that it is their own fault. . . . He must have goats and corn. 'No goats, no rain; that's our contract, my friends,' says Katchiba. . . . Should his people complain of too much rain, he threatens to pour storms and lightning upon them for ever, unless they bring him so many hundred baskets of corn, etc. . . . His subjects have the most thorough confidence in his power." And the king is similarly supposed to have power over the weather among the people of Loango.

A like connection is traceable in the records of various extinct peoples in both hemispheres. Of Huitzilopochtli, the founder of the Mexican power, we read that "a great wizard he had been, and a sorcerer"; and every Mexican king on ascending the throne had to swear "to make the sun go his course, to make the clouds pour down rain, to make the rivers run, and all fruits to ripen." Reproaching his subjects for want of obedience, a Chibcha ruler told them they knew that "it was in his power to afflict them with pestilence, smallpox, rheumatism, and fever, and to make to grow as much grass, vegetables, and plants as they wanted." Ancient Egyptian records yield indications of a similar early belief. Thothmes III, after being deified, "was considered as the luck-bringing god of the country, and a preserver against the evil influence of wicked spirits and magicians." And it was thus with the Jews: "Rabbinical writers are never weary of enlarging upon the magical power and knowledge of Solomon. He was represented as not only king of the whole earth, but also as reigning over devils and evil spirits, and having the power of expelling them from the bodies of men and animals, and also of delivering people to them." The traditions of European peoples furnish kindred evidence. As before shown, stories in the "Heims-kringla Saga" imply that the Scandinavian ruler, Odin, was a medicine-man; as were also Niot and Frey, his successors. And after recalling the supernatural weapons and supernatural achievements of early heroic kings, we can scarcely doubt that with them were in some cases associated the supposed magical powers whence have descended the supposed powers of kings to cure diseases by touching or otherwise. We shall the less doubt this on finding that like powers were ascribed to subordinate rulers of early origin. There were certain ancient Breton nobles whose spittle and touch had curative properties.

One important factor, then, in the genesis of political headship,

originates with the ghost-theory, and the concomitant rise of a belief that some men, having acquired power over ghosts, can obtain their aid. Generally the chief and the medicine-man are separate persons; and there then exists between them some conflict: they have competing authorities. But, where the ruler unites with his power, naturally gained, this ascribed supernatural power, his authority is necessarily much increased. Recalcitrant members of his tribe, who might dare to resist him if bodily prowess alone could decide the struggle, do not dare to do this if they believe he can send one of his *posse comitatus* of ghosts to torment them. That rulers desire to unite the two characters we have, in one case, distinct proof. Canon Callaway tells us that, among the Amazulu, a chief will endeavor to discover a medicine-man's secrets and afterward kill him.

Still there recurs the question, How does permanent political headship arise? Such political headship as results from bodily power, or courage, or sagacity, even when strengthened by supposed supernatural aid, ends with the life of any savage who gains it. The principle of efficiency, physical or mental, while it tends to produce a temporary differentiation into ruler and ruled, does not suffice to produce a permanent differentiation. There has to coöperate another principle, to which we now pass.

Already we have seen that even in the rudest groups age gives some predominance. Among both Fuegians and Australians, not only old men, but old women, exercise authority. And that this respect for age, apart from other distinction, is an important factor in establishing political subordination, is implied by the curious fact that, in sundry advanced societies characterized by extreme governmental coercion, the respect due to age takes precedence of all other respect. Sharpe remarks of ancient Egypt that "here as in Persia and Judea the king's mother often held rank above his wife." In China, notwithstanding the inferior position of women socially and domestically, there exists this supremacy of the female parent, second only to that of the male parent; and the same thing occurs in Japan. As supporting the inference that subjection to parents prepares the way for subjection to rulers, I may add a converse fact. Of the Coroados, whose groups are so incoherent, we read that "the *pajé*, however, has as little influence over the will of the multitude as any other, for they live without any bond of social union, neither under a republican nor a patriarchal form of government. Even family ties are very loose among them . . . there is no regular precedency between the old and the young, for age appears to enjoy no respect among them." And, as reënforcing this converse fact, I may add that, as I have shown elsewhere, the Mantras, the Caribs, the Mapuchés, the Brazilian Indians, the Gallinomeros, the Shoshones, the Navajos, the Californians, the Comanches, who submit very little or not at all to

chiefly rule, display a filial submission which is mostly small and ceases early.

But now under what circumstances does respect for age take that pronounced form seen in societies distinguished by great political subordination? It was pointed out that when men, passing from the hunting stage into the pastoral stage, began to wander in search of food for their domesticated animals, they fell into conditions favoring the formation of that patriarchal group, at once family and miniature society, constituting the unit of composition of societies which reach the highest stages of evolution. We saw that, in the primitive pastoral horde, the man, dissociated from those earlier tribal influences which interfere with paternal power, and which prevent settled relations of the sexes, was so placed as to acquire headship of a coherent group: the father became, "by right of the strong hand, leader, owner, master, of wife, children, and all he carried with him." There were enumerated the influences which tended to make the eldest male a patriarch; and it was shown that not only the Semites, Aryans, and Turanians have exemplified this relation between pastoral habits and the patriarchal organization, but that it recurs in South African races.

Be the causes what they may, however, we find abundant proof that this family supremacy of the eldest male, common among pastoral peoples and peoples who have passed through the pastoral stage into the agricultural stage, naturally develops into political supremacy. Of the Santals Hunter says: "The village government is purely patriarchal. Each hamlet has an original founder (the manjhi-hanan), who is regarded as the father of the community. He receives divine honors in the sacred grove and transmits his authority to his descendants." Of the compound family among the Khonds we read in Macpherson that "there it [paternal authority] reigns nearly absolute. It is a Khond's maxim that a man's father is his god, disobedience to whom is the greatest crime; and all the members of a family live united in strict subordination to its head until his death." And the growth of groups thus arising, into compound and doubly compound groups, acknowledging the authority of one who unites family headship with political headship, has been made familiar by Sir Henry Maine and others as common to early Greeks, Romans, Teutons, and as still affecting social organization among Hindoos and Slavs.

Here, then, we have making its appearance a factor which conduces to permanence of political headship. As was pointed out in a foregoing chapter, while succession by efficiency gives plasticity to social organization, succession by inheritance gives it stability. No settled arrangement can arise in a primitive community so long as the function of each unit is determined exclusively by his fitness; since, at his death, the arrangement, in so far he was a part of it, must be recommenced. Only when his place is forthwith filled by one whose claim is admitted, does there begin a differentiation which survives

through successive generations. And evidently in the earlier stages of social evolution, while the coherence is small and the want of structure great, it is requisite that the principle of inheritance should, especially in respect of the political headship, predominate over the principle of efficiency. Contemplation of the facts will make this clear.

Two primary forms of hereditary succession have to be considered. The system of kinship through females, common among rude peoples, results in descent of property and power to brothers or to the children of sisters; while the system of kinship through males, general among advanced peoples, results in descent of property and power to sons or daughters. We have first to note that succession through females results in less stable political headships than does succession through males.

From the fact named, when treating of the domestic relations, that the system of kinship through females arises where unions of the sexes are temporary or unsettled, it is to be inferred that this system characterizes societies which are unadvanced in all ways, political included. We saw that irregular connections involve paucity and feebleness of known relationships, and a type of family the successive links of which are not strengthened by so many collateral links. A common consequence is, that along with descent through females there goes either no chieftainship, or chieftainship is established by merit, or, if hereditary it is usually unstable. The Australians and Tasmanians may be named as typical instances. Among the Haidahs and other savage peoples of Columbia "rank is nominally hereditary, for the most part by the female line"; and actual chieftainship "depends to a great extent on wealth and ability in war." Of other North American tribes, the Chippewas, Comanches, and Snakes, show us the system of kinship through females joined with either absence of hereditary chieftainship or very feeble development of it. Passing to South America, the Arawaks and the Waraus may be instanced as having female descent and almost nominal though hereditary chiefs; and much the same may be said of the Caribs.

A group of facts having much significance may now be noted. In many societies where descent of property and rank in the female line is the rule, an exception is made in the case of the political head; and the societies exemplifying this exception are societies in which political headship has become relatively stable. Though in Feejee there is kinship through females, yet, according to Seemann, the ruler, chosen from the members of the royal family, is "generally the son" of the late ruler. In Tahiti, where the two highest ranks follow the primitive system of descent, male succession to rulership is so pronounced that, on the birth of an eldest son, the father becomes simply a regent on his behalf. And among the Malagasy, along with a prevailing kinship through females, the sovereign either nominates his successor, or,

failing this, the nobles appoint, and, "unless positive disqualification exists, the eldest son is usually chosen." Africa furnishes evidence of varied kinds. Though the Congo people, the coast negroes, and the inland negroes, have formed societies of some size and complexity, notwithstanding that kinship through females obtains in the succession to the throne, yet we read of the first that allegiance is "vague and uncertain"; of the second, that, save where free in form, the government is "an insecure and short-lived monarchic despotism"; and of the third, that, where the government is not of mixed type, it is "a rigid but insecure despotism." Meanwhile, in the two most advanced and powerful states, stability of political headship goes along with departure, partial or complete, from succession through females. In Ashantee the order of succession is "the brother, the sister's son, the son"; and in Dahomey there is male primogeniture. Further instances of this transition are yielded by extinct American civilizations. Though the Aztec conquerors of Mexico brought with them the system of kinship through females, and consequent law of succession, yet this law of succession was partially, or completely, changed to succession through males. In Tezcuco and Tlacopan (divisions of Mexico) the eldest son inherited the kingship; and in Mexico the choice of a king was limited to the sons and brothers of the preceding king. Then, of ancient Peru, Gomara says, "Nephews inherit, and not sons, except in the case of the Incas": this exception in the case of the Incas having the strange peculiarity that "the first-born of this brother and sister [i. e., the Inca and his principal wife] was the legitimate heir to the kingdom"—an arrangement which made the line of descent unusually narrow and definite. And here we are brought back to Africa by the parallelism between the case of Peru and that of Egypt. "In Egypt it was maternal descent that gave the right to property and to the throne. The same prevailed in Ethiopia. If the monarch married out of the royal family, the children did not enjoy a legitimate right to the crown." When we add the statement that the monarch was "supposed to be descended from the gods, in the male and female line," and when we join with this the further statement that there were royal marriages between brother and sister, we see that like causes worked like effects in Egypt and in Peru. For in Peru the Inca was of supposed divine descent; inherited his divinity on both sides; and married his sister to keep the divine blood unmixed. And in Peru as in Egypt there resulted royal succession in the male line, where, otherwise, succession through females prevailed.

With this process of transition from the one law of descent to the other, implied by these last facts, may be joined some processes which preceding facts imply. In New Caledonia a "chief nominates his successor, if possible, in a son or brother": the one choice implying descent in the male line and the other being consistent with descent in either male or female line. And in Madagascar, where the system of

female kinship prevailed, "the sovereign nominated his successor—naturally choosing a son." Further, it is to be noted that, where, as in these cases, when no nomination has been made, the nobles choose among members of the royal family, and are determined in their choice by eligibility, there may be, and naturally is, a departure from descent in the female line; and this once broken through is likely, for several reasons, to be abolished. We are also introduced to another transitional process. For some of these cases are among the many in which succession to rulership is fixed in respect of the family, but not fixed in respect of the member of the family—a stage implying a partial but incomplete stability of the political headship. Several instances occur in Africa. "The crown of Abyssinia is hereditary in one family, but elective in the person," says Bruce. "Among the Timmanees and Bulloms, the crown remains in the same family, but the chief or headmen of the country, upon whom the election of a king depends, are at liberty to nominate a very distant branch of that family." And a Caffre "law requires the successor to the king should be chosen from among some of the youngest princes." In Java and Samoa, too, while succession to rulership is limited to the family, it is but partially settled with respect to the individual.

That stability of political headship is secured by establishment of descent in the male line is, of course, not alleged. The assertion simply is, that succession after this mode conduces better than any other to its stability. Of probable reasons for this, one is that in the patriarchal group, as developed among those pastoral races from which the leading civilized peoples have descended, the sentiment of subordination to the eldest male, fostered by circumstances in the family and in the gens, becomes instrumental to a wider subordination in the larger groups eventually formed. Another probable reason is, that with descent in the male line there is more frequently a union of efficiency with supremacy. The son of a great warrior, or man otherwise capable as a ruler, is more likely to possess kindred traits than is the son of his sister; and, if so, it will happen that in those earliest stages, when personal superiority is requisite as well as legitimacy of claim, succession in the male line will conduce to maintenance of power by making usurpation more difficult.

There is, however, a more potent influence which aids in giving permanence to political headship, and which operates more in conjunction with descent through males than in conjunction with descent through females—an influence probably of greater importance than any other.

When showing how respect for age generates patriarchal authority where descent through males has arisen, I gave cases which incidentally showed a further result; namely, that the dead patriarch, worshiped by his descendants, becomes a family deity. In sundry chap-

ters of Vol. I were set forth at length the proofs, past and present, furnished by many places and peoples, of this genesis of gods from propitiated ghosts. Here there remains to be pointed out the strengthening of political headship inevitably thus effected.

Descent from a ruler who when alive was distinguished by superiority, and whose ghost, specially feared, comes to be propitiated in so unusual a degree as to distinguish it from ancestral ghosts at large, exalts and supports the living ruler in two ways. In the first place, he is assumed to inherit from his great progenitor more or less of the character, apt to be considered supernatural, which gave him his power; and, in the second place, making sacrifices to this great progenitor, he is supposed to maintain such relations with him as insure divine aid. Passages in Canon Callaway's account of the Amazulu show the influence of this belief. It is said, "The itongo [ancestral ghost] dwells with the great man, and speaks with him"; and then it is also said, referring to a medicine-man: "The chiefs of the house of Uzulu used not to allow a mere inferior to be even said to have power over the heaven; for it was said that the heaven belonged only to the chief of that place." These facts yield us a definite interpretation of others, like the following, which show that the authority of the terrestrial ruler is increased by his supposed relation to the celestial ruler; be the celestial the ghost of the remotest known ancestor who founded the society, or of a conquering invader, or of a superior stranger.

Of the chiefs among the Kukis, who are descendants of Hindoo adventurers, we read: "All these rajahs are supposed to have sprung from the same stock, which it is believed originally had connection with the gods themselves; their persons are therefore looked upon with the greatest respect and almost superstitious veneration, and their commands are in every case law." Of the Tahitians Ellis says: "The god and the king were generally supposed to share the authority over the mass of mankind between them. The latter sometimes impersonated the former. . . . The kings, in some of the islands, were supposed to have descended from the gods. Their persons were always sacred." According to Mariner, "*Toritonga* and *Veachi* (hereditary divine chiefs in Tonga) are both acknowledged descendants of chief gods who formerly visited the islands of Tonga." And, in ancient Peru, "the Inca gave them (his vassals) to understand that all he did with regard to them was by an order and revelation of his father, the Sun."

This reënforcement of natural power by supernatural power becomes extreme where the ruler is at once a descendant of the gods and himself a god; a union of attributes which is familiar among peoples who do not distinguish between the divine and the human as we do. It was thus in the case just instanced—that of the Peruvians. It was thus with the ancient Egyptians. The monarch "was the rep-

resentative of the Divinity on earth, and of the same substance"; and not only did he in many cases become a god after death, but he was worshiped as a god during life; as witness the following prayer to Rameses II:

> When they had come before the king . . . they fell down to the ground, and with their hands they prayed to the king. They praised this divine benefactor, . . . speaking thus: "We are come before thee, the lord of heaven, lord of the earth, sun, life of the whole world, lord of time, . . . lord of prosperity, creator of the harvest, fashioner and former of mortals, dispenser of breath to all men; animater of the whole company of the gods, . . . thou former of the great, creator of the small, . . . thou our lord, our sun, by whose words out of his mouth Tum lives, . . . grant us life out of thy hands . . . and breath for our nostrils."

This prayer introduces us to a remarkable parallel. Rameses, whose powers, demonstrated by his conquests, were regarded as so transcendent, is here described as ruling not only the lower world but also the upper world; and a like royal power is alleged in two existing societies where absolutism is similarly unmitigated—China and Japan. As shown when treating of "Ceremonial Institutions," both the Emperor of China and the Japanese Mikado have such supremacy in heaven that they promote its inhabitants from rank to rank at will.

That this strengthening of political headship, if not by ascribed godhood then by ascribed descent from a god (either the apotheosized ancestor of the tribe or one of the elder deities), was exemplified among the early Greeks, needs not be shown. It was exemplified, too, among the Northern Aryans. "According to the old heathen faith, the pedigree of the Saxon, Anglian, Danish, Norwegian, and Swedish kings—probably also those of the German and Scandinavian kings generally—was traced to Odin, or to some of his immediate companions or heroic sons."

It is further to be noticed that a god-descended ruler who is also chief priest of the gods (as he habitually is) obtains a more effectual supernatural aid than does the ruler to whom magical powers alone are ascribed. For in the first place the invisible agents invoked by the magician are not conceived to be those of highest rank; whereas the divinely-descended ruler is supposed to get the help of a supreme invisible agent. And, in the second place, the one form of influence over these dreaded superhuman beings tends much less than the other to become a permanent attribute of the ruler. Though among the Chibchas we find a case in which magical power was transferred to a successor—though "the cacique of Sogamoso made known that he [Bochica] had left him heir of all his sanctity, and that he had the same power of making rain when he liked," and giving health or sickness (an assertion believed by the people)—yet this is an exceptional case. Speaking generally, the chief whose relations with the supernatural world are those of a sorcerer does not transmit his relations; and he

does not, therefore, establish a supernatural dynasty, as does the chief of divine descent.

And now, having considered the several factors which coöperate to establish political headship, let us consider the process of coöperation through its ascending stages. The truth to be noted is, that the successive phenomena which occur in the simplest groups habitually recur in the same order in compound groups, and again in doubly compound groups.

As, in the simple group, there is at first a state in which there is no headship, so, when simple groups which have political heads possessing slight authorities are associated, there is at first no headship of the cluster. The Chinooks furnish an example. Describing them, Lewis and Clarke say: "As these families gradually expand into bands, or tribes, or nations, the paternal authority is represented by the chief of each association. This chieftain, however, is not hereditary." And then comes the further fact, which here specially concerns us, that "the chiefs of the separate villages are independent of each other": there is no general chieftainship.

As headship in the simple group, at first temporary, ceases when the war which initiates it ends, so, in the cluster of groups which severally have recognized heads, a common headship at first results from a war, and lasts no longer than the war. Falkner says, "In a general war, when many nations enter into an alliance against a common enemy," the Patagonians "chose an *apo*, or commander-in-chief, from among the oldest or most celebrated of the caciques." The Indians of the upper Orinoco live "in hordes of forty or fifty under a family government, and they recognize a common chief only in times of war." So is it in Borneo. "During war the chiefs of the Sarebas Dyaks give an uncertain allegiance to a head chief, or commander-in-chief." It has been the same in Europe. Seeley remarks that the Sabines "seem to have had a central government only in war-time." Again: "Germany had anciently as many republics as it had tribes. Except in time of war, there was no chief common to all, or even to any given confederation."

This recalls the fact indicated when treating of political integration, that the cohesion within compound groups is less than that within simple groups, and again that the cohesion within the doubly compound less than that within the compound. What was there said of cohesion may here be said of subordination; for we find that, when by continuous war a permanent headship of a compound group has been generated, it is less stable than the headships of the simple groups. Often it lasts only for the life of the man who achieves it; as among the Karens and the Maganga, and as among the Dyaks, of whom Boyle says: "It is an exceptional case if a Dyak chief is raised to an acknowledged supremacy over the other chiefs. If he is so raised he

can lay no claim to his power except that of personal merit and the consent of his former equals; and his death is instantly followed by the disruption of his dominions." Even when there has arisen a headship of the compound group which lasts beyond the life of its founder, it remains for a long time not equal in stability to the headships of the component groups. Pallas, while describing the Mongol and Calmuck chiefs as having unlimited power over their dependents, says that the khan had in general only an uncertain and weak authority over the subordinate chiefs. Of the Caffres we read: "They are all vassals of the king, chiefs, as well as those under them; but the subjects are generally so blindly attached to their chiefs that they will follow them against the king." Europe has furnished kindred examples. Of the Homeric Greeks Mr. Gladstone writes: "It is probable that the subordination of the sub-chief to his local sovereign was a closer tie than that of the local sovereign to the head of Greece." And, during the early feudal period in Europe, allegiance to the local ruler was stronger than that to the general ruler.

In the compound group, as in the simple group, the progress toward stable headship is furthered by the transition from succession by choice to succession by inheritance. During early stages of the simple tribe, chieftainship, whe nnot acquired by individual superiority tacitly yielded to, is acquired by election. In North America it is so with the Aleuts, the Comanches, and many more; in Polynesia it is so with the Land Dyaks; and, before the Mohammedan conquest, it was so in Java. Among the hill-races of India it is so with the Nagas and others. In some regions the transition to hereditary succession is shown by different tribes of the same race. Of the Karens we read that "in many districts the chieftainship is considered hereditary, but in more it is elective." Some Chinook villages have chiefs who inherit their powers, though mostly they are chosen.

Similarly, the compound group is at first ruled by an elected head. Sundry examples come to us from Africa. Bastian says that "in many parts of the Congo region the king is chosen by the petty princes." The crown of Yariba is not hereditary—"the chiefs invariably electing, from the wisest and most sagacious of their own body." And the King of Ibu, says Allen, seems to be "elected by a council of sixty elders, or chiefs of large villages." In Asia it is thus with the Kukis: "One, among all the rajahs of each class, is chosen to be the Prudham or chief rajah of that clan. The dignity is not hereditary, as is the case with the minor rajahships, but is enjoyed by each rajah of the clan in rotation." So has it been in Europe. Though by the early Greeks hereditary right was in a considerable measure recognized, yet the case of Telemachus implies "that a practice, either approaching to election, or in some way involving a voluntary action on the part of the subjects, or of a portion of them, had to be gone through." The like is true of ancient Rome. That the monarchy was

elective "is proved by the existence in later times of an office of *interrex*, which implies that the kingly power did not devolve naturally upon an hereditary successor." Later on it was thus with Western peoples. Up to the beginning of the tenth century "the formality of election subsisted . . . in every European kingdom; and the imperfect right of birth required a ratification by public assent." And it was once thus with ourselves. Among the early English the bretwaldship, or supreme headship over the minor kingdoms, was at first elective; and the form of election continued long traceable in our history.

The stability of the compound headship, made greater by efficient leadership in war and by establishment of hereditary succession, is further increased when there coöperates the additional factor—supernatural origin or supernatural sanction. Everywhere, up from a New Zealand king who is strictly *tapu*, or sacred, we may trace this influence; and occasionally, where divine descent or magical powers are not claimed, there is a claim to origin that is more than human. Asia yields an example in the Fodli dynasty, which reigned a hundred and fifty years in south Arabia—a six-fingered dynasty, regarded with awe by the people because of its continuously-inherited malformation. Europe of the Merovingian period yields an example. In pagan times the king's race had an alleged divine origin; but in Christian times, says Waitz, as they could no longer mount back to the gods, the myth still clung to the supernatural: "A sea-monster ravished the wife of Chlogio as she sat by the seashore, and from this embrace Merovech sprang." Later days show us the gradual acquisition of a sacred or semi-supernatural character where it did not originally exist. Divine assent to their supremacy was alleged by the Carlovingian kings. During the later feudal age, rare exceptions apart, kings "were not far removed from believing themselves near relatives of the masters of heaven. Kings and gods were colleagues." In the seventeenth century this belief was justified by divines. "Kings," says Bossuet, "are gods, and share in a manner the divine independence."

So that the headship of a compound group, first arising temporarily during war, becoming with frequent coöperation of the groups settled for life, by election, passing presently into the hereditary form, and becoming more stable as fast as the law of succession becomes well defined and undisputed, acquires its greatest stability only when the king becomes a deputy-god, or when, if his supposed godlike nature is not, as in primitive societies, derived from alleged divine descent, it is replaced by a divine commission guaranteed by ecclesiastical authority.

Where the political head has acquired this absoluteness which results from supposed divine nature, or divine descent, or divine commission, there is naturally no limit to his sway. In theory, and often

to a large extent in practice, he is owner of his subjects and of the territory they occupy.

Where militancy is pronounced and the claims of a conqueror unqualified, it is indeed to a considerable degree thus with those uncivilized peoples who do not ascribe supernatural characters to their rulers. Among the Zooloo Caffres the chief "exercises supreme power over the lives of his people"; "the Bheel chiefs have a power over the lives and property of their own subjects"; and in Feejee the subject is property. But it is still more thus where the ruler is considered more than human. Astley tells us that in Loango the king is "called *samba* and *pongo*, that is, god"; and, according to Proyart, the Loango people "say their lives and goods belong to the king." In Wasoro, East Africa, "the king has unlimited power of life and death . . . in some tribes . . . he is almost worshiped." In Msambara the people say, "We are all slaves of the Zumbe (king), who is our Mulungu" (god). "By the state law of Dahomey, as at Benin, all men are slaves to the king, and most women are his wives"; and in Dahomey the king is called "the spirit." The Malagasy speak of the king as "our god"; and he is lord of the soil, owner of all property, and master of his subjects. Their time and services are at his command." In the Sandwich Islands the king, personating the god, utters oracular responses; and his power "extends over the property, liberty, and lives of his people." Various Asiatic rulers, whose titles ascribe to them divine descent and nature, stand in like relations to their peoples. In Siam "the king is master not only of the persons but really of the property of his subjects; he disposes of their labor and directs their movements at will." Of the Burmese we read, "Their goods likewise, and even their persons, are reputed his [the king's] property, and on this ground it is that he selects for his concubine any female that may chance to please his eye." In China "there is only one who possesses authority—the Emperor. . . . A wang, or king, has no hereditary possessions, and lives upon the salary vouchsafed by the Emperor. . . . He is the only possessor of the landed property."

Of course, where unlimited power is possessed by the political head —where, as victorious invader, his subjects lie at his mercy, or where, as divinely descended, his will may not be questioned without impiety, or where he unites the characters of conqueror and god—he naturally absorbs every kind of authority; he is at once military head, legislative head, judicial head, ecclesiastical head. The fully developed king is the supreme center of every social structure and the director of every social function.

In a small tribe it is practicable for the chief personally to discharge all the duties of his office. Besides leading the other warriors in battle, he has time enough to settle disputes, he can sacrifice to the ancestral ghost, he can keep the village in order, he can inflict punishment, he

can regulate trading transactions; for those governed by him are but few, and they lie within a narrow space. When he becomes the head of many united tribes, both the increased amount of business and the wider area covered by his subjects put difficulties in the way of exclusively personal administration. It becomes necessary for him to employ others for the purposes of gaining information, conveying commands, and seeing them executed; and, in course of time, the assistants thus employed become established heads of departments with deputed authorities.

While this development of governmental structures in one way increases the ruler's power, by enabling him to deal with more numerous affairs, it in another way decreases his power, for his actions are more and more modified by the instrumentalities through which they are effected. Those who watch the working of administrations, no matter of what kind, have forced upon them the truth that a head regulative agency is at once helped and hampered by its subordinate agencies. In a philanthropic association, a scientific society, or a club, those who govern find that the organized officialism which they have created often impedes, and not unfrequently defeats, their aims. Still more is it so with the immensely larger administrations of the state. Through deputies the ruler receives his information; by them his orders are executed; and, as fast as his connection with affairs becomes indirect, his control over affairs diminishes; until, in extreme cases, he either lapses into a puppet in the hands of his chief deputy or has his place usurped by him.

Strange as it seems, the two causes which conspire to give permanence to political headship, also, at a later stage, conspire to reduce the political head to an automaton, executing the wills of the agents he has created. In the first place, hereditary succession, when finally settled in some line of descent rigorously prescribed, involves that the possession of supreme power becomes independent of capacity for exercising it. The heir to a vacant throne may be, and often is, too young for discharging its duties; or he may be, and often is, too feeble in intellect, too deficient in energy, or too much occupied with the pleasures which his position offers in unlimited amounts; with the result that in the one case the regent, and in the other the chief minister, becomes the actual ruler. In the second place, that sacred character which he acquires from supposed divine ancestry makes him inaccessible to the ruled. All intercourse with him must be through the agents with whom he surrounds himself. Hence it becomes difficult or impossible for him to learn more than they choose him to know; and there follows inability to adapt his commands to the requirements, and inability to discover whether his commands have been fulfilled. His authority is consequently used to give effect to the purposes of his agents.

Even in so relatively simple a society as that of Tonga, we find an

example. There is an hereditary sacred chief who "was originally the sole chief, possessing temporal as well as spiritual power, and regarded as of divine origin," but who is now politically powerless. Abyssinia shows us something analogous. Holding no direct communication with his subjects, and having a sacredness such that even in council he sits unseen, the monarch is a mere dummy. In Gondar, one of the divisions of Abyssinia, the king must belong to the royal house of Solomon, but any one of the turbulent chiefs who has obtained ascendancy by force of arms becomes a Ras—a prime minister or real monarch; but he requires "a titular emperor to perform the indispensable ceremony of nominating a Ras," since the name, at least, of emperor "is deemed essential to render valid the title of Ras." The case of Thibet may be named as one in which the sacredness of the original political head is dissociated from the claim based on hereditary descent; for the Grand Lama, considered as "God the Father," incarnate afresh in each new occupant of the throne, does not receive his divine nature by natural descent, but, receiving it supernaturally, is discovered among the people at large by certain indications of his godhood; and with his divinity, involving disconnection with temporal matters, there goes absence of political power. A like state of things exists in Bootan. "The Dhurma Raja is looked upon by the Bootanese in the same light as the Grand Lama of Thibet is viewed by his subjects—namely, as a perpetual incarnation of the Deity, or Buddha himself in a corporeal form. During the interval between his death and reappearance, or, more properly speaking, until he has reached an age sufficiently mature to ascend his spiritual throne, the office of Dhurma Raja is filled by proxy from among the priesthood." And then along with this sacred ruler there coexists a secular one. Bootan "has two nominal heads, known to us and to the neighboring hill-tribes under the Hindoostanee names of the Dhurma and the Deb Rajas. . . . The former is the spiritual head, the latter the temporal one." Though in this case it is said that the temporal head has not great influence (probably because the priest-regent, whose celibacy prevents him from founding a line, stands in the way of unchecked assumption of power by the temporal head), still the existence of a temporal head implies a partial lapsing of political functions out of the hands of the original political head. But the most remarkable and at the same time most familiar example is that furnished by Japan. Here the supplanting of inherited authority by deputed authority is exemplified, not in the central government alone, but in the local governments. "Next to the prince and his family came the *karos* or 'elders.' Their office became hereditary, and, like the princes, they in many instances became effete. The business of what we may call the clan would thus fall into the hands of any clever man or set of men of the lower ranks, who, joining ability to daring and unscrupulousness, kept the princes and the *karos* out of

sight, but, surrounded with empty dignity and commanding the opinion of the bulk of the *samarai* or military class, wielded the real power themselves. They took care, however, to perform every act in the name of the *fainéants*, their lords, and thus we hear of . . . daimios, just as in the case of the Emperors, accomplishing deeds and carrying out policies of which they were perhaps wholly ignorant." This lapsing of political power into the hands of ministers was, in the case of the central government, doubly illustrated. Successors as they were of a god-descended conqueror whose rule was real, the Japanese Emperors gradually became only nominal rulers; partly because of the sacredness which separated them from the nation, and partly because of the early age at which the law of succession frequently enthroned them. Their deputies consequently gained predominance. The regency in the ninth century "became hereditary in the Fujiwara [sprung from the imperial house], and these regents ultimately became all-powerful. They obtained the privilege of opening all petitions addressed to the sovereign, and of presenting or rejecting them at their pleasure." And then, in course of time, this usurping agency had its own authority usurped in like manner. Again succession by fixed rule was rigorously adhered to; and again seclusion entailed loss of hold on affairs. "High descent was the only qualification for office, and unfitness for functions was not regarded in the choice of officials." Besides the Shôgun's four confidential officers, "no one else could approach him. Whatever might be the crimes committed at Kama Koura, it was impossible, through the intrigues of these favorites, to complain of them to the Shôgun." The result was that "subsequently this family . . . gave way to military commanders, who," however, often became instruments in the hands of other chiefs.

Though less definitely, this process was exemplified during early times in Europe. The Merovingian kings, to whom there clung a tradition of supernatural origin, and whose order of succession was so far settled that minors reigned, fell under the control of those who had become chief ministers. Long before Childeric the Merovingian family had ceased really to govern. "The treasures and the power of the kingdom had passed into the hands of the prefects of the palace, who were called 'mayors of the palace,' and to whom the supreme power really belonged. The prince was obliged to content himself with bearing the name of king, having flowing locks and a long beard, sitting on the chair of state, and representing the image of the monarch."

From the evolution standpoint we are thus enabled to discern the relative beneficence of institutions which, considered absolutely, are not beneficent, and are taught to approve as temporary that which, as permanent, we abhor. The evidence obliges us to admit that subjection to despotic rulers has been largely instrumental in advancing civilization. Induction and deduction alike prove this.

If, on the one hand, we group together those wandering, headless

hordes, belonging to different varieties of man, which are found here and there over the earth, they show us that, in the absence of political organization, little progress has taken place; and, if we contemplate those settled simple groups which have but nominal heads, we see that, though there is some development of the industrial arts and some coöperation, the degree of advance is but small. If, on the other hand, we glance at those ancient societies in which considerable heights of civilization were first reached, we see them under autocratic rule. In America purely personal government, restricted only by settled customs, characterized the Mexican, Central American, and Chibcha states; and in Peru the absolutism of the divine king was unqualified. In Africa, ancient Egypt exhibited in the most conspicuous manner this connection between despotic control and social evolution. Throughout the distant past it was repeatedly displayed in Asia, from the Accadian civilization downward, and the still extant civilizations of Siam, Burmah, China, and Japan reillustrate it. Early European societies, too, where not characterized by centralized despotism, were still characterized by diffused patriarchal despotism. Only among modern peoples, whose ancestors passed through the discipline given under this social form, and who have inherited its effects, is there arising an habitual dissociation of civilization from subjection to individual will.

The necessity there has been for absolutism is best seen on observing that, in the struggles for existence among societies, those have conquered which, other things equal, were the more subordinate to their chiefs and kings. And, since in early stages military subordination and social subordination go together, it results that, for a long time, the conquering societies continue to be the despotically governed societies. Such exceptions as histories appear to show us really prove the rule. In the conflict between Persia and Greece, the Greeks, but for a mere accident, would have been ruined by that division of councils which results from absence of subjection to a single head. And the habit of appointing a dictator, when in great danger from enemies, implies that the Romans had discovered that efficiency in war requires absoluteness of control.

So that, leaving open the question whether, in the absence of war, primitive groups could ever have developed into civilized nations, we conclude that, under such conditions as there have been, those struggles for existence, among societies which have gone on consolidating smaller into larger until great nations have been produced, necessitated the development of a social type characterized by personal rule of a stringent kind.

To make clear the genesis of this leading political institution, let us set down in brief the several influences which have conspired to effect it, and the several stages passed through.

In the rudest groups, resistance to the assumption of supremacy by any individual habitually prevents the establishment of settled headship, though some influence is commonly acquired by superiority of strength, or courage, or sagacity, or possessions, or the experience which accompanies age.

In such groups, and in tribes somewhat more advanced, two kinds of superiority conduce more than all others to predominance—that of the warrior and that of the medicine-man. Often separate, but sometimes united in the same person, and then greatly strengthening his hands, both these superiorities, tending to initiate political headship, continue thereafter to be important factors in the development of it.

At first, however, the supremacy acquired by a great natural power, or supposed supernatural power, or both, is transitory—ceases with the life of one who has acquired it. So long as the principle of efficiency alone operates, political headship does not become settled. It becomes settled only when there coöperates the principle of inheritance.

The custom of reckoning descent through females, which characterizes many rude societies and survives in others that have made considerable advances, is less favorable to establishment of permanent political headship than is the custom of reckoning descent through males; and, in sundry semi-civilized societies distinguished by permanent political headships, inheritance through males has been established in the ruling house, while inheritance through females survives in the society at large.

Beyond the fact that reckoning descent through males conduces to a more coherent family, to a greater culture of subordination, and to a more probable union of inherited position with inherited capacity, there is the more important fact that it fosters ancestor-worship and the consequent reënforcing of natural authority by supernatural authority. Development of the ghost-theory, leading as it does to special fear of the ghosts of powerful men, until, where many tribes have been welded together by a conqueror, his ghost acquires in tradition the preëminence of a god, produces two effects. In the first place, his descendant, ruling after him, is supposed to partake of his divine nature; and, in the second place, by propitiatory sacrifices to him, is supposed to obtain his aid. Rebellion hence comes to be regarded as alike wicked and hopeless.

The processes by which political headships are established repeat themselves at successively higher stages. In simple groups chieftainship is at first temporary—ceases with the war which initiated it. When simple groups that have acquired permanent political heads unite for military purposes, the general chieftainship is but temporary. As in simple groups chieftainship is at the outset habitually elective, and becomes hereditary at a later stage, so chieftainship of the compound group is at the outset habitually elective, and only later passes

into the hereditary. Similarly in some cases where a doubly compound society is formed. Further, this later-established power of a supreme ruler, at first given by election and presently growing hereditary, is commonly less than that of the local rulers in their own localities; and where it becomes greater it is usually by the help of ascribed divine descent or ascribed divine commission.

Where, in virtue of supposed supernatural origin or authority, the king has become absolute, and, owning both subjects and territory, exercises all powers, he is obliged by the multiplicity of his affairs to depute his powers. There follows a reactive restraint due to the political machinery he creates; and this machinery ever tends to become too strong for him. Especially where rigorous adhesion to the rule of inheritance brings incapables to the throne, or where ascribed divine nature causes inaccessibility save through agents, or where both causes conspire, power passes into the hands of deputies. The legitimate ruler becomes an automaton and his chief agent the real ruler, who, in some cases passing through parallel stages, himself becomes an automaton and his subordinates the rulers.

THE BLACK RACES OF OCEANICA.*

By Dr. R. VERNEAU.

NEGRO forms are figured among the earliest representations of men on ancient monuments. As early as the eighteenth dynasty (seventeen hundred years before the Christian era), the artists of Egypt represented at least five races of negroes. Nigritic types were also figured by the Greeks, Romans, Assyrians, Babylonians, and Persians, although none of those people had as extended knowledge of Africa as the Egyptians had. The examination of all the monuments which have come down from antiquity makes it evident that the negro races of Africa and Asia were well known. Scientific investigations of negro characteristics began to be made in the sixteenth century. The first to record one was Albert Dürer, who, in 1525, drew a profile of a negro inclosed in a system of lines, of which an oblique and an horizontal line formed at their junction a real facial angle. MM. de Quatrefages and Hamy, in their "Crania Ethnica," begin the study of the negro races with the negroes of Oceanica, and select as their point of departure the Negritos, the most brachycephalic race. The Negrito race proper, which was first observed in the Philippine Islands, has been found in the interior of the Peninsula of Malacca, the Sunda Islands, and the Andaman Islands. M. Hamy has been able to trace it even to the interior of India.

* Translated from the French by W. H. Larrabee.

The pure Negrito skull (Fig. 3) is sub-brachycephalic, having a mean index (cephalic, or horizontal) of 81·79; its capacity is from 1,310 to 1,535 cubic centimetres. The occipito-frontal curve is quite regular, and presents a depression over the forehead, another toward the third posterior of the sagittal suture, and an undulation at the level of the sinciput; passing the occipital protuberance, it turns sharply down-

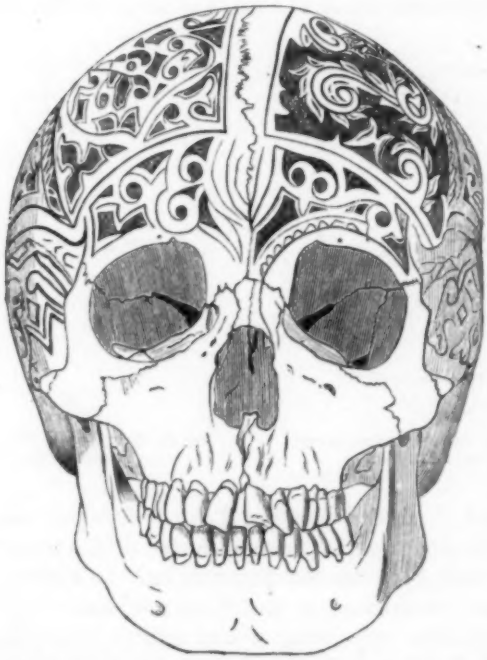


Fig. 1.—Skull of a Negrito of Borneo, carved by the Dyaks. (From the Museum of Lyons.)

ward. The frontal, narrow before, is well developed in the antero-posterior direction; the short length of the cranium corresponds with the shortness of the parietal and occipital bones.

In the face, the prominences of the brows are not very distinct, the space between the orbits is relatively considerable, the orbits are wide, almost square, the canine cavity is little marked, the prognathism is distinct in the middle alveolar region of the superior maxillary. The whole of the face is moderately elongated, showing a mean facial index of 67·17. The Mincopies, who live in the Andaman Islands, had already been studied by M. de Quatrefages, and his opinion that they almost exactly resemble the Aétas of the Philippine Islands is confirmed by the description of them in the "Crania Ethnica." The only difference is in a slightly higher elevation of the cranium, as is shown in the sketch.

Negritos whose history is fully described in this work are still liv-

ing in the mountains of India and Indo-China, and in the Malay Peninsula. The race is nearly extinct in the Sunda Islands, but it seems to appear again in Timor ; and a head from that island, in the collection of the museum, reproduces, apart from some details of the facial bony structure, all the characteristics of the Mincopie heads. An elegantly carved skull from Borneo, belonging to the Museum of Lyons, also presents the same traits (Fig. 1).

The detailed examination of twelve skulls from the interior of New

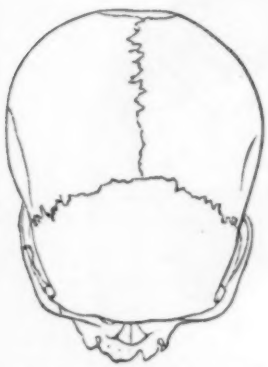


FIG. 2.—SKULL OF A NEGRITO OF THE PHILIPPINE ISLANDS.

FIG. 3.—SKULL OF A MINCOPIE OF THE ANDAMAN ISLANDS.

Guinea, Rawak, Boni, the Island of Toud, and Amberbaki, has allowed the authors to recognize in those different points the existence of an intermediate race between the Negritos and the Papuans, which they have, therefore, designated as the Negrito-Papuan race. The skulls of this intermediate type (Fig. 4) are slightly elongated, with their mean index descending to 80·15, while the facial index rises to 67·17, and the maxillary prognathism is much more sharply defined than among the Negritos. Some of these heads have been artificially deformed.

The Negrito-Papuan race forms, in some respects, a transition between the Negritos proper and the Tasmanians. The description given of the last race, which is now extinct, is based on the study of numerous skulls in the collections of the Museums of Paris, London, Shelton, etc., and other authentic sources of information. The Tasmanians were differentiated from other oceanic negroes by a number of characteristics, and the study of their skulls enables us to make of them a special race, remarkably homogeneous, notwithstanding the differences which prevailed in the languages of the several tribes.

The index of the Tasmanian skull varied from 77·10 among the southern tribes to 76·34 among the northern tribes. Its mean capacity, 1,420 centimetres in men's skulls, was notably superior to that of negro skulls in general. It presented a special form, a kind of keel-shape,

which seemed to exist in all the adult Tasmanians, and which resulted from the disposition of the parietal bosses, they being very prominent, almost conical, and situated at an equal distance from the coronal and lambdoidal sutures. Between these prominences existed, on each side of the sagittal suture, itself placed in a hollow, an antero-posterior groove which contributed to give the skull its peculiar characteristic

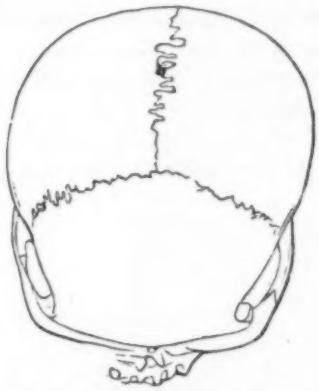


FIG. 4.—SKULL OF A PAPUAN NEGRITO OF RAWAK.

FIG. 5.—SKULL OF A TASMANIAN.

form. It results from this considerable development of the parietal bosses that, below them, the figure of the skull was descending without swelling out, the maximum transverse diameter being nearly on a level with them. The antero-posterior curve was developed regularly to the occipital bone, which was very much swelled out, so that at this level the curve was slightly inflected upward ; at the summit of the occipital crest it was often abruptly inflected downward. The forehead was quite narrow. The face was not much raised, and exhibited brutal forms. The arches of the brows were prominent, and appeared more projecting than they were, on account of the sunken position of the root of the nose. The nasal bones, convex and pinched above, were deeply hollowed in their lower part, and were then lifted up to flatness in front. The very wide nasal orifice almost formed an equilateral triangle. The superior maxillary was notably prognathous, but the teeth, much less oblique than the bone, descended sometimes even vertically, and were of considerable size. The horizontal branch of the inferior maxillary was robust and thick, while the ascending branch was thin and narrow. The mandible was very short, so that the teeth had to be projected considerably forward to meet those of the superior maxillary. The chin was retreating.

The Malays gave the name of Papuans to the Oceanian negroes in general. The term, which signifies *frizzled*, is properly applied to the group who are distinguished by their bushy hair, and is now reserved for the race whose representatives are more or less numerously found

in nearly all of Melanesia and in part of Australia. The Papuan skull is plainly dolichocephalous; the index descends to 71·03, and even to 70·32 in the skulls of the men. The vertical diameter is at the same time considerable, and exceeds the maximum transverse diameter, so that the head is hypsistenocephalous, or higher than it is broad. The head which MM. de Quatrefages and Hamy have selected as typical of the race—a Mafor head from Port Dorei—(Fig. 6) has an horizontal index of 71·55, and a vertical index of 105·51, with a cranial capacity of about 1,350 cubic centimetres. It is long, narrow, and high. The lateral walls of the skull rise perpendicularly, in almost parallel lines, to the parietal bosses. At this point the transverse curve is directed obliquely toward the top of the head, where it becomes rounded, and forms, in connection with a kind of median crest which crosses the

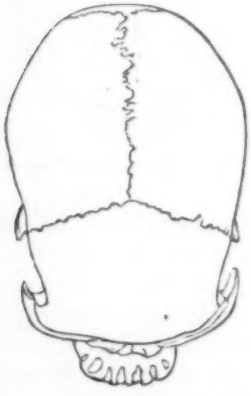


FIG. 6.—SKULL OF A PAPUAN MAFOR.

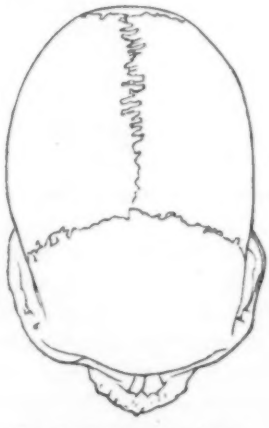


FIG. 7.—SKULL FROM ARFAK.

skull from front to rear, along the whole length of the sagittal suture, a large, blunt point. The forehead is narrow, causing the cheek-bones to appear very prominent, although their lateral development is not, really, at all exaggerated. As a whole, the face is high and narrow. The bones of the nose are quite long and slightly concave, the cavities and prominences of the lower part of the superior maxillary are not clearly defined. The prognathism of this race is so sharp that in the *norma verticalis* the alveolar border and a part of the bones above project in front of the skull. The facial angle of Camper varies between 73° and 76°. The Papuan woman is generally less dolichocephalous and hypsistenocephalous than the man.

Pure or more or less mixed Papuans are found in Ternate, Ceram, and Timor, in Malaysia. The pure type occurs in New Britain, and at Vanikoro in the New Hebrides, but in other parts of Melanesia it is mixed with the Negrito-Papuan or the Polynesian type. Traces of the former mixture may be detected in the Island of Toud, although

the greater part of the inhabitants of that island are real Papuans, and even in New Guinea.

The Polynesian type may be perceived in the Louisiade Archipelago and in all eastern Melanesia, beginning at the Solomon Islands. In some of the islands it is almost pure. The Papuan-Polynesians, concerning which we have the most information, are those of the Loyalty and Feejee Islands and New Caledonia. The Papuan type is occasionally found pure in those groups, but is most frequently mixed with the Polynesian, and in these cases the mixture is accentuated by marked phenomena. The heads of the half-breeds are less dolicho-

Fig. 8.—Bust of a Native of New Guinea.

cephalous and less hypsistenocephalous than Papuan heads, without reaching the Polynesian proportions. The modifications in the face are more complicated. Papuans are found at the extremities of Polynesia, as far north as the Sandwich Islands, as far south as New Zealand, and as far east as Easter Island, where they have been carried by voluntary or accidental migrations, or in slavery. They also occur erratically in some islands of Micronesia, particularly the Caroline Islands and in Rawak.

The Australian skulls in the European museums appear to arrange themselves into two homogeneous series, which do not, however, indicate a distinction of race, as M. Topinard believes, but seem to be determined by differences of sex. The man differs more from the woman in this than in any other race. There are, however, other races than the Australian in New Holland, as sporadic Melanesians and Indonesians; but, laying aside these casual cases and a few exceptional

cases in Queensland and southern Australia, it may be said that Australian skulls of the same sex are alike, and that those of the interior populations differ from those of natives of the coast only in a little greater development, corresponding with their larger stature. This superiority is the result of better conditions of existence. It is enough, therefore, to describe two types: the Australian type proper, to which

FIG. 9.—BUST OF AN ISLANDER OF TOUD (TORRES STRAITS).

most of the known tribes belong; and the *Neanderthaloid* type, found only among a few southern tribes, the most of which are in process of extinction.

The head which has been selected as a type of the former race is that of an individual from Port Essington. It has a cranial capacity of only 1,250 cubic centimetres, while the average of Australian skulls is 1,285 cubic centimetres, and is very dolichocephalous and hypsistenocephalous—that is, is elongated from front to rear, and is higher than broad. The indices are horizontal 67·21, vertical 105·69. The prominences of the brows are voluminous, as is also the glabella, which appears to be prolonged over the forehead. The medial prominence of the forehead is quite marked, the lateral ones are nearly effaced. The parietals present an analogous disposition: their inner borders rise along the sagittal suture so as to form a kind of roof, while the bosses are hardly indicated. The curved lines on the occipital form thick and prominent puffs; the bone is flattened over the cerebellum, and presents well-defined muscular impressions. The antero-posterior curve is regular to near the lambdoidal suture, whence it rises to the occipi-

tal. The most marked characters in the face are the thickness of the external orbital processes, the forward projection of the cheek-bones, the depression of the root of the nose, the shortness and breadth of the nose, and the mode of termination of the bridge of the nose, which, instead of forming an angle, is prolonged into a kind of a gutter. The jaws are narrow and the branches of the dental arch tend to be parallel. The palatal vault is deep; and the prognathism is very

FIG. 10.—BUST OF A TASMANIAN.

great, the mean alveolar facial angle being 64°, but the massive teeth are less oblique than the alveolar part.

In the women the prominences of the brows nearly disappear, while the parietal bosses are more accentuated. The forehead and the lower occipital bone are more swollen; the antero-posterior curve is relatively depressed, although the skull continues to show the form of a roof. The prognathism of the face is more marked, and the teeth are more inclined than in the men.

The second Australian type, the dolichoplatycephalic or Neanderthaloid type, although it is less widely diffused than the other, is nevertheless of very great interest to anthropologists. In it there exist, as Huxley has already remarked, individuals and even a whole race, although it is disappearing, that present the cranial forms of which the Neanderthal man affords the most pronounced example. We are

not, then, authorized to believe that the Neanderthal skull was one of an idiot, or of any exceptional being not possessing the ethnic characters of the race which lived at the same epoch with him. If there still exists a race offering the same characteristics, there is no reason why that race may not have existed in a geological age anterior to our own. The Australian skull of the Neanderthaloid type, which is found, ac-

FIG. 2.—BUST OF A TASMANIAN.

cording to Huxley, in Queensland, is also met as an erratic in New South Wales. But a tribe, seeming to belong entirely to the race under consideration, lived only in the environs of Adelaide; and the seven pieces from which the studies of the type were made are from that locality.

MM. de Quatrefages and Hamy conclude their study of the Australian race with an enumeration of the cranial characteristics which distinguish the Papuans from the Australians, and a comparison of those races with the Dravidian races of the interior of India. Common characteristics appear in both groups, and resemblances may be traced between the Australian and Dravidian languages. The evidence, however, is still too slight to permit us to assign a common origin to the races of New Holland and the black races of India.—*La Nature.*

PHYSICAL EDUCATION.

By FELIX L. OSWALD, M. D.

OUT-DOOR LIFE.

"Disease is a hot-house plant."—HALLER.

EVERY disease is a protest of Nature against an active or passive violation of her laws. But that protest follows rarely upon a first transgression, never upon trifles; and life-long sufferings—the effects of an incurable injury excepted—generally imply that the sufferer's mode of life is habitually unnatural in more than one respect. For there is such a thing as vicarious atonement in pathology: a strict observance of any one of the three or four principal health-laws rarely fails to reward itself by a long immunity from the consequences of otherwise evil habits. Frugality thus counteracts the morbific tendency of indolence; perfect continence may steel even a feeble constitution against the effects of hunger and overwork; and, by avoiding the great vice of intemperance, the Epicureans atoned for a multitude of minor sins.

But the surest of all natural prophylactics is active exercise in the open air. Air is a part of our daily food and by far the most important part. A man can live on seven meals a week, and survive the warmest summer day with seven draughts of fresh water, but his supply of gaseous nourishment has to be renewed at least fourteen thousand times in the twenty-four hours. Every breath we draw is a draught of fresh oxygen, every emission of breath is an evacuation of gaseous recrements. The purity of our blood depends chiefly on the purity of the air we breathe, for in the laboratory of the lungs the atmospheric air is brought into contact at each respiration with the fluids of the venous and arterial systems, which absorb it and circulate it through the whole body; in other words, if a man breathes the vitiated atmosphere of a factory all day and of a close bedroom all night, his life-blood is tainted fourteen thousand times in the course of the twenty-four hours with foul vapors, dust, and noxious exhalations. We need not wonder, then, that ill-ventilated dwellings aggravate the evils of so many diseases, nor that pure air should be almost a panacea.

Out-door life is both a remedy and a preventive of all known disorders of the respiratory organs; consumption, in all but the last stage of the *deliquium*, can be conquered by transferring the battle-ground from the sick-room to the wilderness of the next mountain-range. Asthma, catarrh, and tubercular phthisis, are unknown among the nomads of the intertropical deserts, as well as among the homeless hunters of our Northwestern Territories. Hunters and herders, who breathe the pure air of the South American pampas, subsist for years

on a diet that would endanger the life of a city dweller in a single month. It has been repeatedly observed that individuals who attained to an extreme old age were generally poor peasants whose avocations required daily labor in the open air, though their habits differed in almost every other respect; also that the average duration of life in various countries of the Old World depends not so much on climatic peculiarities or their respective degree of culture as on the chief occupation of the inhabitants; the starved Hindoo outlives the well-fed Parsee merchant, the unkempt Bulgarian enjoys an average longevity of forty-two years to the west Austrian citizen's thirty-five.

In the cities of the higher latitudes, sedentary occupations in a vitiated atmosphere become often a sort of "second nature": artisans and shopkeepers, after following their business for a number of years, frequently come to dislike fresh air, as the convent slave, by an analogous suppression of his better instincts, becomes averse to free inquiry. But this abnormal indolence seldom becomes hereditary—perhaps never, if we except the children of inebriate idiots. The mediæval prejudice against all natural propensities—founded on the dogma of innate depravity—is, indeed, strikingly refuted by a young child's love of out-door exercise. Without the mediation of supernatural revelators or preternatural bugbears, a healthy boy prefers even the hardships of our northern winter sports to the atmosphere of a comfortable stove-room, and in summer-time the paradise of childhood is still a tree-garden. No domestic events of our later years can efface the impression of the woodland rambles, butterfly hunts, and huckleberry expeditions of our boyhood: the recollections of our first out-door adventures endure like the mountains and rivers of a promised land whose cities have vanished for ever.

I have often been asked at what age infants can first be safely exposed to the influence of the open air. My answer is, On the first warm, dry day. There is no reason why a new-born child should not sleep as soundly under the canopy of a garden-tree on a pillow of sun-warmed hay as in the atmosphere of an ill-ventilated nursery. Thousands of sickly nurslings, pining away in the slums of our manufacturing towns, might be saved by an occasional *sun-bath*. Aside from its warmth and its chemical influence on vegetal oxygen, sunlight exercises upon certain organisms a vitalizing influence which science has not yet quite explained, but whose effect is illustrated by the contrast between the weeds of a shady grove and those of the sunlit fields, between the rank grass of a deep valley and the aromatic herbage of a mountain meadow, as well as by the peculiar wholesome appearance of a "sunburned" person or a sun-ripened fruit. Sunlight is too cheap to become a fashionable remedy, but its hygienic influence can hardly be overrated. Even in the glorious climate of the Latian hills, the Roman Epicureans constructed special *solaria*—glass-covered turrets—where they could bask in the full rays of the winter

sun, the balm of old age, as Columella calls it; and, on the summerless Isle of Rügen, Nature has taught the poor fishermen to carry their bairns to the downs of Stubbenkammer, whenever the Baltic fogs alternate with a few sunny days. Dry sand is, indeed, an excellent medium of solar caloric. Children like it instinctively; most babies are fond of rummaging in some tangible, yielding element. In default of a sunny beach, get a car-load of river-sand, spread it and expose it to the sun for a couple of hours, then rake it together, mix it *ad captandum* with a bushel of pebbles (good-sized ones, lest they might be mistaken for sugar-plums), divest your *bambino* of all superfluous clothing, and let him wallow—all afternoon, if he chooses; if the surface of the pile gets too warm, instinct will teach him to dig down to the cooler substrata. Or take him to a meadow where fresh hay has been piled up in little stacks; climbing and tumbling will do him more good than lying motionless in a narrow baby-carriage. The inventor of the Kindergarten recommends a grassy hollow with scattered playthings, piles of dry leaves, etc. (near a shade-tree in midsummer), where young squealers can take care of themselves for an hour or two, and warrants that they will not cry, unless their botanic researches should happen to acquaint them with the properties of the German horse-nettle. On mild winter days, too, self-motive babies ought to pass a few hours out of doors, even if the ground be a little wet; a sunny nook on the lee-side of a garden-wall is a healthier playground than the dusty floor of a stove-room.

From the fourth to the end of the fourteenth year children should spend the larger part of every summer in out-door exercises. Next to a total reform of our dietetic habits, a general observance of this rule would be the surest way to regain the hardiness and longevity of our forefathers. The years of growth lay the foundation of our bodily constitution, and, under favorable circumstances, the human system, during that period, seems to accumulate a surplus of physical vigor, which in after-life will become available as an annuity-fund of health and happiness. Education, like charity, ought to begin at home; in boarding-colleges, protectories, orphan asylums, etc., the rudiments should be taught in *winter schools*. At the price of life-long infirmities precocious erudition is too dear-bought; besides, it should not be forgotten that in the years when students can take a personal interest in their lessons they will make more progress in a single month than during years of involuntary confinement in boy-pens, as Dr. Salzmann calls our municipal baby-schools. The employment of young children in cotton-factories is a crime against society, and ought to be legally prohibited, like the trade in Italian organ-boys and Chinese slave-girls. Swiss artisans, who have passed their boyhood in the mountains, are comparatively proof against the influence of in-door occupations. And, in the mean time, out-door life need not be a life of idleness. That children are fond of play means simply that they pre-

fer entertaining employments to tedious ones. Youngsters under five years gambol instinctively like young puppies, in order to acquire the art of locomotion, but soon afterward they begin to play with a conscious purpose, and do not object to playing at something profitable; young savages and peasant-boys join in the labors of their parents with an eagerness that vindicates human nature against the charge of innate frivolity. Make your boy a Jack-of-all-out-door-trades before you make him a classic polyglot, and, if you destine him for any trade in special, let him play with the tools of that special trade. "The best plan of education," says Goethe, "is that of the Hydriotes, the Greek trading-sailors, who take their infant boys out to sea and let them sport around amid oakum and belaying-pins before they learn to handle them with a business purpose. Such a school has graduated the heroes who with their own hands could grapple the fire-boat to the flag-ship of the enemy."

Even for their children's sake, married men should never quarter their families in the heart of a great city. Not everybody can own a farm, but, wherever the suburban cottages adjoin waste building-lots and dry ravines, there will be no lack of opportunities for out-door pastimes. Let the girls make weed-brooms, and the boys construct fortifications, *à la* Uncle Toby, if they can do no better, and miss no chance to send them out in the country for a day or two. Our town parks are too exclusive; sauntering between inviolate grass-plots and prohibitory placards is dull work for urchins that long to commit horse-play; but there are few cities, even on the Atlantic seaboard, where the "open country"—woods, fallow fields, and hillsides—could not be reached by a two hours' walk. There let your children spend every sunny afternoon; make arrangements with your neighbors, and engage a guide if you can not afford to go yourself; teach the youngsters to collect beetles and butterflies, encourage the fern mania if your girl has outgrown the buttercup period, connive at a bird's nest or two, do anything to keep them out of the tenement dungeons. If you are blessed with a farm (or a tolerant country cousin), haymaking, apple-gathering, turkey-herding, repairing of ditches and garden-walls, will make earth an Elysium to every normal child; never mind the weather; a summer shower, a chilly morning, or a hot afternoon will not hurt a healthy boy, and the girls will take care of themselves—or rather of their dress—if the grass is wet. If you send them to school before their teens, give them at least the full benefit of their vacations and of every free Saturday. In fall and winter a day of athletic field-sports will keep a boy in tolerable health for the rest of the week, and a vacation tour of six or eight weeks may atone for many months of sedentary life.

In the preceding chapter I have pointed out the main cause of catarrhal affections. With the exception of deep-seated breast-coughs, "colds" may be nipped in the bud by a few hours of hard, *sudorific*

work in the open air. It may be an heroic cure, requiring a good deal of will-force in cold weather, but it is an infallible and the only radical remedy. In half a day the nasal ducts and the perspiratory exhalants will throw off irritating matters which would defy the drug-doctor for a couple of weeks, or yield only to exercise their influence in another direction, for poison-remedies merely change the form of a disease. But the beneficial effect of out-door exercise is not limited to the respiratory organs: their quickened function reacts on the digestive apparatus, on the nervous system, and through the nerves on the mind; true mental and physical vigor in any form can be maintained only on a liberal allowance of life-air; those who feed their lungs on miasma become strangers to that exuberant health which makes bare existence a luxury. After years of in-door life the victims of melancholy, dyspepsia, and dull headaches come to accept their discomforts as the normal condition of mankind, but upon the first appearance of such disorders our instinct suggests the cause and the cure with an urgency which makes confinement in the atmosphere of our northern dwelling-houses the greatest affliction of childhood. If we reflect on the fact that our earth is surrounded by a respirable atmosphere of at least eight hundred million cubic miles, it seems a sad comment on the enlightenment of modern civilization that the unsatisfied thirst after life-air should inflict more misery upon millions of our fellow-men than hunger and all the hardships of poverty combined. "On the day of judgment," says Jean Paul, "God will perhaps pardon you for starving your children when bread was so dear; but, if he should charge you with *stinting them in his free air*, what answer shall you make?"

Perfect health depends upon a daily supply of fresh air as much as on our daily bread; but within certain limits the human organism is capable of adapting itself to abnormal circumstances. A man may accustom himself to devour his weekly allowance of solid food at a single meal, and in a similar way the vitalizing elements of air and sunshine can be hoarded up—allotropically, for all we know—for days, weeks, and months in advance. The Zooloo hunter who, after a six days' fast, gets a chance to satisfy the cravings of his stomach, can not be expected to content himself with half-pint rations *à la* Luigi Cornaro, and in midsummer, after six months of sedentary life, a boy should get his fill of out-door exercises; let him drink sunlight at every pore, do not stint his allowance of oxygen, compensate him for long arrears of woodland air and mountain-rambles.

With a little experience vacation trips can be managed very cheaply. Professor Jordan, of the Ilefeld *Pedagogium*, takes his summer boarders to the Hartz, or even to the Austrian Alps, at an aggregate daily expense of fifteen marks (three and a half dollars) for twenty or twenty-five big boys with North-German appetites. They carry their own beds in the form of a plaid and a pair of foot-sacks (boot-

like felt socks), and sleep wherever they find a shade-tree or an open barn. Their portable commissariat consists of biscuits and brown sugar; with fresh milk and such *entremets* as the mountain inns may afford, they make out two good meals a day, besides occasional luncheons of nuts and huckleberries. Twenty-two of the twenty-four hours are thus spent in the open air, but the long summer days are almost too short for all the entertainments on the liberal professor's programme. Zoölogy, botany, and geology are only collateral pursuits, the main thing is the uproarious fun in the mountains; climbing cliffs, tumbling bowlders from projecting rocks, and chasing squirrels from tree to tree do not endanger the toilet of the excursionists, for every one of them wears *turner-drell*, a sort of coarse linen, as tough, though not quite as soft, as corduroy.

Observant managers of such expeditions soon get rid of the dismal prejudices against cold spring-water, "wet feet," and "untimely baths." The craving of a thirsty wanderer after cold water is not an abnormal appetency, but a natural instinct, and can be indulged with perfect impunity; a bath in sun-warmed river-water is healthy as long as it is enjoyable; South-Sea Islanders and the children of the Genoese fishermen spend whole afternoons in the surf, and—barring sharks and medusas—without fear of dangerous consequences. There is no harm in wet stockings as long as the feet are in motion; at home it is perhaps better to change them at once, though the Canadian lumbermen dry them on their legs before the camp-fire, or even in bed—i. e., under a pair of "Mackinaw blankets," which blankets have often served as overcoats during the day, but in the course of the night are dried by the animal warmth like a pack of wet sheets. Sunstrokes can be obviated by a simple and very inexpensive precaution—temporary abstinence from animal food. A refrigerating diet (vegetables, fruit, etc.) counteracts the effect of a high atmospheric temperature, but the calorific influence of meat and fat, combined with solar heat and bodily exertion, overcomes the organic power of resistance, the pyretic blood-changes produce congestion of the brain and sometimes instant death. I venture the assertion that in nineteen out of twenty cases of comatose sunstroke it will be found that the victims were persons who had gone to work in the hot sun after a meal of greasy viands. One to two P. M. is the sunstroke-hour.

Among the permanent benefits which young persons may derive from a pedestrian tour, it is not the least that they will mostly get rid of the night-air superstition. Sweet rest and pleasant dreams he knows not who has never slept under a Mexican live-oak tree on a bundle of fresh-plucked Spanish moss, or in the loft of a Tennessee cotton-gin while the winds of the summer night play in draughts and counter-draughts through four open louvres. The advantages of a hardy education in all such things are quite incalculable; the word *hardiness* sums up the chief characteristics that distinguished the

moral and physical life of the ante-Christian ages from the scrofulous effeminacy of our stove-room civilization.

The teachers of the *Pedagogium* and similar institutions assured me that their scholars were never more *aufgeweckt* (wide-awake) than during the first six or eight weeks after the long vacations; even the drawing-masters had no reason to complain about "club-fists." It is a very common but quite erroneous notion that the burly strength of the human hand impairs its capacity for delicate manipulations: the iron-fisted Gemsen-jäger of the Tyrolese Alps are the nicest marksmen; and Leonardo da Vinci, who could draw a perfect circle without a compass, could not the less break a silver piaster between his two thumbs and two forefingers.

The Ilefelders were also the first to make Saturday an hygienic sabbath. In spring and fall, all such Saturdays should be consecrate to the wood-gods; leaf-forests, under the influence of sunlight, exhale the antidote of our atmospheric poisons. Start the youngsters at sunrise with a basketful of cold meats, and orders for an equal quantity of strawberries, or, if the woods are safe, let them go on Friday night, and camp in the open air; they will long for the advent of that night as Tom-a-lin for the festival of the fairies. Let them rise with the sun and spend the whole day in active exercise, the merrier the better; in a mountain country arrange a new programme for every week, explore the local Ararats, and let the boys scale them in succession, as the members of the Alpine Club tackle their bergs and horns. If the weather should disappoint you, do not hesitate to *improve* the next sunny day, though it should happen to be a Sunday. The God of Nature can be worshiped in his own temple: the wonder of his living world is his most authentic revelation. Where Sunday is the only free day in the week, no puritanical tyranny or Jesuitical ingenuity will ever prevent the poor from making it a day of recreation; the only question is, whether that recreation shall be sought in the secret rumshops and back-alleys of the city, whose gates the sabbatarians would shut upon us, or in the free woods and mountains, where the worshiper of the All-Father can find inspiration as well as joy and health. The wood-thrush, it is true, does not modulate her anthems in a whining drawl; the pine-tree lifts his head without fear of provoking his Creator by a want of crawling humility; no dread of a joy-hating priest-god disturbs the gambols of the squirrel and the aërial dances of the brook-midge; the butterfly and the humming-bird do not think it necessary to "mortify the eye with dreary drab," but their happiness imparts a lesson not less divine for being at variance with the doctrines of an atrabilious fanatic.

According to the Grecian allegory, the wood-craft goddess Diana was the antagonist of the Cyprian Venus; and a *penchant* for out-door sports is indeed the best safeguard against certain vices of youth. The precocious Don Juans of our great cities could be more easily re-

formed by a hunting expedition to the next Sierra Nevada than by all the homilies of Fray Gerundio. Like depraved humors, prurient propensities yield to active exercise more readily than to physic and prayer. Hunting tribes are generally continent, stalwart, and comely; wood air is a cosmetic; the finest types of the human form are not found within the precincts of the Palais Royal, but in the Caucasus and the Kentucky forest counties.

Enjoyable winter excursions are a privilege of the rich; still, a pair of good skates make a convenient pond or a small river a great blessing. From a sanitary point of view, the neighborhood of larger streams is not so much of an advantage; besides being the terror of parents during the skating season, a big river is apt to render the contiguous lowlands more or less malarious, especially after every inundation. In snow-bound villages children have to depend mainly on indoor exercises; cold air, however, is a powerful tonic, and a two hours' snowball-fight will generally suffice to vitalize a juvenile constitution for a couple of days. Mountain air, too, is a peptic stimulant, and pedestrian excursions are doubly invigorating if they include a good deal of up-hill work.

For those who wish to select their dwelling-place with regard to the hygienic interest of their children, the best location is, therefore, on the whole, the bank of a small river in the neighborhood of a large mountain-range.

HISTORY OF CHRONOLOGY.

By Professor E. S. BURNS.

CHRONOLOGY is the science of the measurement of time, of ascertaining and fixing dates, which constitute the landmarks by which the mind is guided in its backward course through the long vista of years, and enabled to locate and fix the events of history, the knowledge of which would otherwise be a confused and wellnigh useless attainment. The advanced state of astronomical science and the experience of those who have gone before us have enabled us to reduce all that pertains to this subject to so complete a system that we lose sight of its magnitude and importance; we forget the slow progress and toilsome research which the great minds of past centuries had to undergo to reach the present state of correctness. To appreciate even faintly this magnitude, we must transport ourselves backward a few thousand years, and forget, if we can, the improvements of modern astronomy, the developments of mathematics, and, above all, the universality and ubiquity of modern almanacs.

The first and most obvious division of time is the day—the time required for a revolution of the earth upon its axis—which could not

have been a very difficult matter to ascertain with sufficient correctness. But to mark and fix the time of the sun's apparent revolution through the heavens among the stars was a matter of so great difficulty that it was not exactly ascertained even at the time of the reformation of the calendar in 1582; yet so uniform is the motion of the earth in its orbit that the results of modern experiments render it next to absolutely certain that the time of orbital revolution has never varied even the fraction of a second. In the infancy of astronomy, many ingenious expedients were adopted to ascertain this and other matters connected with the times and motions of the planets and other heavenly bodies, one of which may be mentioned even at the risk of tediousness. To ascertain the exact time of the revolution of the concave of the heavens, two vessels were placed over each other, the upper filled with water, the lower empty. At the moment of the appearing of a certain star above the horizon, the water was permitted to flow from the upper into the lower vessel, and the flow was continued until the same star appeared the next night, when the flow was stopped. The whole concave of the heavens had then made one revolution. The water which had flowed out during this time was then divided into twelve equal parts, and smaller vessels were made each to hold just one of those parts, and on the following evening they repeated the operation, filling successively six of those vessels, and noting carefully what stars rose above the horizon during the time required to fill each of them. Each group of stars which rose during the time of filling one small vessel was called a *station* or *house* of the sun. They then postponed operations upon the other half of the heavens for six months, when they repeated it, and thus divided the path of the sun through the whole heavens into twelve divisions, to most of which they gave the names of certain animals: hence the term *zodiac*, the propriety of which could have been seen only by the fertile fancies of the childhood of the race. The whole ancient method of dividing and naming the constellations is to us utterly absurd, and is really a hindrance to a knowledge of the stars. Fanciful forms of snakes and dogs and lions and bulls and wagons and scorpions convey to us no idea but one of confusion and perplexity, and they are tolerated for the same reasons that we tolerate our bungling orthography: we are loath to break away from the associations of antiquity; we are loath to sever the giant strides of Science, in its strength and manhood, from the feeble totterings of its infancy.

The time required by the sun to pass through one of these groups or signs is nearly equal to a lunar month; the time required to pass through three of them was called a season, as we have it now. All this was done by the Chaldeans or Egyptians, centuries before Greece or Rome had inhabitants or a name.

The Greeks divided the year into twelve lunar months, but, as this lunar year differed from the true year by about eleven days, they cor-

rected the error, after many other devices, by intercalating three months every eight years, making every eighth year consist of fifteen months—a method used by them for many years, perhaps centuries. It is said, however, that the length of the year was known, as early as the time of Solon, to be three hundred and sixty-five and one quarter days. Prior to the time of Numa, the Roman year consisted of ten months. He divided it into twelve lunar months, and to correct the error of eleven days a month was intercalated every second year. The management of this matter was intrusted to the priests, who added days whenever they deemed them necessary. But, owing to their ignorance of astronomy, this method proved irregular and erroneous, and the winter months were gradually carried back into autumn, the autumn months into summer, etc.

These errors had become so troublesome in the time of Julius Cæsar that he undertook, with the aid of an eminent astronomer (Sosigenes), to correct the calendar, which was done as follows: The Roman civil year had lost about ninety days. These were added to the year of three hundred and fifty-five days, making that year consist of four hundred and forty-five days, which is known in history as the "year of confusion." The year henceforward was made to consist of three hundred and sixty-five days, by adding ten days distributively to as many months. The odd quarter of a day was not noted until every fourth year, when the sum of these fourths made one day, and that year consisted of three hundred and sixty-six days. This odd day was inserted after the sixth day before the kalends of March, i. e., after the 24th of February, and was not counted as an addition to the year, but as a sort of appendix. Hence the sixth of the kalends of March was called bissextus, or double sixth, which root is still retained in our word bissextile, though the day is now added at the *end* of February. This arrangement would have been entirely correct had the year consisted of exactly three hundred and sixty-five and one quarter days. It was, however, in course of time, discovered to be erroneous, and another correction was made, which we will consider by and by. This new system went into effect on January 1, 46 B. C.

The subdivisions of the Roman month were apparently arbitrary. The days were not numbered as we have them, but the first day of every month was called the *calends*, the fifth the *nones*, and the thirteenth the *ides*, except in the months of March, May, July, and October, when the nones fell on the seventh and the ides on the fifteenth. From these points the days were counted backward—i. e., the last of February was called Prid., Kal., Mar., etc.

NAMES OF MONTHS.—The division of days into weeks was invented at a very early day by the Chaldeans, and was afterward adopted by almost all civilized nations, and by the Romans about the third century A. C. The principle upon which the days were named is odd enough to deserve especial notice. The order of the planets, according to the

Ptolemaic system, was: 1. Saturn; 2. Jupiter; 3. Mars; 4. Sun; 5. Venus; 6. Mercury; 7. Moon. The Chaldeans called the twenty-four hours of the day by the names of these planets in their order, and named each day from the first hour of the day. Thus, first hour of first day was Saturn; last hour (or twenty-fourth) was Mars; first hour of next day was Sun, hence called Sunday; first hour of next day Moon, hence called Monday, etc. Our Saxon ancestors named the days from their corresponding gods. Thus, what the Romans called Mars-day, the Saxons called Tuisco-day (whence Tuesday), Tuisco being their god of war as Mars was among the Romans, and so of the rest.

The early Romans began the year with March, but in the time of Cæsar it began with January. The early Christian Church began it on March 25th, and this was the beginning of the civil and ecclesiastical year in England and her American colonies until 1752, when it was changed by act of Parliament to January 1st.

Cycles.—To facilitate computation of time, to fix the recurrence of moons and days, and to establish epochs as standpoints of chronology, recourse was had to cycles, which we will now examine. The word *cycle* is derived from a Greek word which signifies a circle—here it signifies a circle of time. The first and most important among them was the Cycle of the Moon, the object of which was to accommodate the computation of time by the moon to that of the sun. It was invented about 430 B. C., by an Athenian named Meton, whence it was called also the Metonic Cycle, and was used to fix the times of the Grecian festivals, but fell into disuse with these festivals and was afterward restored by the Council of Nice, A. D. 325, being best adapted of all to fixing the time of Easter.

This cycle, at the time of its invention, was deemed entirely correct, and was so much superior to any other that had been attempted that each year was written in letters of gold in the public marts of Greece, from which cause it has ever since been known as the "golden number." It was constructed as follows: It had been discovered that the lunar year was eleven days shorter than the solar year; so that, if a new moon occurred upon any given day of any solar year, on the same day of the next solar year the moon would be eleven days old, on the same day of the second year twenty-two days old, etc. Examination showed that the new moon would again occur upon the same day of the solar year in the course of nineteen years. Hence the lunar cycle consists of nineteen years. The other ancient cycles are unimportant for our present purpose; the other cycles that we shall consider are the inventions of modern chronologers.

Solar Cycle.—Chronologers have affixed to the seven days of the week the first seven letters of the alphabet, as follows: To January 1, A; January 2, B, etc., and whichever letter the first Sunday of the year happens to fall upon is called the dominical or Sunday letter for that year. The object of this cycle is to find (without reference to the

almanac) what day of the week corresponds to any day of any month of any year, and it is constructed in this manner.

As every common year consists of fifty-two weeks and one day, supposing the 1st of January of any year to fall upon Sunday, A will be the Sunday letter for that year. The last day of that year will also be Sunday, and Monday will be the 1st of January of next year; and, as A is always affixed to the first day of the year, G will become the Sunday letter for that year. The next year will begin with Tuesday, which will make its Sunday letter F, etc.; hence, if there were no leap-year, the Sunday letter of each succeeding year would be removed one letter further backward, and in seven years the cycle would be complete, and the Sunday letter of the eighth year would again be A. But, as every leap-year has fifty-two weeks and two days, the letter C, which always belongs to the 28th of February, is also affixed to the 29th, which puts the Sunday letter for the remainder of the year one letter further back. Leap-year has therefore two Sunday letters instead of one, as in common years. This change takes place every four years; the other, as we have seen, would take place in seven years. Hence a complete cycle of the Sunday letter consists of the multiple of seven and four = twenty-eight years; i. e., in any given century, the Sunday letters will again follow each other in exactly the same order every twenty-eight years.

Indiction Cycle.—This is a cycle of fifteen years established by the Emperor Constantine, at the termination of which a tax was levied to pay the soldiers whose term of enlistment was fifteen years. It was afterward ordered by the Council of Nice that this cycle, beginning A. D. 312, should be substituted as the epoch from which all dates should be reckoned instead of that of the Olympiads, which, until that time, seems still to have been used in the Eastern Empire of the Romans.

The epoch from which we now compute years—i. e., the birth of Christ—was not used until about the year 500. The universal adoption of this by all Christendom has obviated the necessity of many of the cycles and epochs used prior to that time, and it is impossible for us now to estimate the difficulties the earlier chronologists had to encounter in their attempts to locate events and to regulate them by some fixed standard (illustrated by different modern weights and measures). The Greeks reckoned by Olympiads — cycles of four years beginning 776 B. C. The Romans' great epoch was the founding of their city, 752 B. C. They also used the lustrum, a cycle of four years; and events are very frequently recorded to have occurred in the consulship of such or such a one. The later Jews used the era of the Seleucidæ, 312 B. C., which era the Nestorians, it is said, still use. Prior to the adoption of our own era, the Christians used the era of Diocletian, 284 A. D.

To harmonize the conflicting and troublesome eras, one Scaliger,

an historian of the early ages of the Church, invented a new cycle to which chronologers might refer all dates. It consisted of the multiple of the years of the three cycles of the sun, moon, and indiction, $28 \times 19 \times 15 = 7{,}890$, and taking these cycles, as settled by the early Church councils, and tracing them backward, he found they would begin together in the year 710 before the creation of the world, according to our received account. This cycle would have been of great value and importance, had it not been superseded by the adoption of the Christian epoch, which, as already said, has made the use of all former epochs and eras unnecessary. The cycle just described is known by the name of the "Julian period."

Several of the ancient cycles were, however, used by the early Church in fixing what are called the "*movable feasts*"; these being regulated not by the solar year, as Christmas or the 4th of July is, but by the lunar year. But, as most of these feasts depend upon or are regulated by Easter, we need consider this one only. In the early days the churches of Asia kept their Easter upon the day on which the Jews celebrated their passover, i. e., on the fourteenth day of their first month, which began with the new moon next after the vernal equinox. The Western churches celebrated on the Sunday following the Jewish festival, both to celebrate the day and to distinguish between Jews and Christians. This difference having finally caused great dissensions in the Church, Constantine had a canon passed at the Council of Nice, that Easter should everywhere be observed upon the same day; and, to prevent disputes thereafter, four paschal canons were also passed, to the effect that "Easter shall always be observed on the first Sunday after the full moon which happens on or next after the 21st of March, which was then the time of the vernal equinox; and, if this full moon happen on Sunday, the Sunday following shall be Easter Sunday."

Then was called into requisition the lunar cycle, and tables were made showing the day of every month in every year, of the cycle on which a new moon would occur, and this table would have been correct for ever had the Julian year been correct and had the moon's cycle been nineteen years to the hour. The former, we have already seen, was not quite correct; and the new moon, although it occurs on the same *day* of the year every nineteenth year, does not occur at the same hour, but about one and a half hour earlier, which difference in a long course of years makes the tables all wrong and useless. In 1582, when the calendar was corrected, the computed equinoxes had been brought forward ten days, so that the full moon, on or after the 21st of March, was not always the first moon after the true vernal equinox—i. e., was not the moon which the Church canon prescribed. The reformation of the calendar, by dropping ten days, brought back the equinox to March 21st, as it was at the time of the Nicene Council.

Immediately after this council the Bishop of Alexandria, in Egypt,

was appointed to give notice to the Pope, and other dignitaries in various parts of the Christian world, of the time when Easter should be celebrated each year, until a perfectly correct cycle should be established. The most prominent cycle framed for this purpose was one by a mathematician named Victorinus. It consisted of the product of the lunar and solar cycle—i. e., $19 \times 28 = 532$. If this calculation had been without defect, any given day would have been the same day of the year, month, moon, and week, that it was five hundred and thirty-two years before or would be five hundred and thirty-two years after.

The Council of Orleans, A. D. 541, decreed that the feast of Easter should be celebrated every year, according to the table of Victorinus. But the tables derived from these data answer only for a limited time on account of the above-mentioned errors in the year and in the lunar cycle. Accordingly, the books which contain tables for finding Easter are good only until the year 1900, when new ones must be made for another period.

As the cycles were fixed by the Latin Church, the era of Christ began in the tenth year of the solar cycle and in the second year of the lunar cycle. Therefore, to find what year of the solar cycle any given year of our Lord is, we add 9 to the number of the year and divide by 28; the remainder, if any, will indicate the number of the year of the cycle. The year of the lunar cycle, i. e., the golden number, is found in a similar manner, by adding 1 to the given year and dividing by 19; the remainder will indicate the year of the lunar cycle.

After the Julian calendar had been used several centuries, the improved state of astronomy disclosed the fact that computed time did not keep pace with actual time, because the year did not consist of three hundred and sixty-five days and six hours but was about eleven minutes ten seconds less. Hence, by inserting an extra day for leap-year, we gain upon true time forty-four minutes, forty seconds, which makes an error of a day in about one hundred and thirty-one years; and hence, in 1582, when the correction of the calendar was undertaken by Pope Gregory, the error had amounted to ten days; i. e., instead of counting just 1,582 years it ought to have been 1,582 years and ten days. A correction was accordingly made by taking a leap of ten days and calling October 5th of that year October 15th. This change, as elsewhere stated, brought the vernal equinox to the 21st of March, where it was at the time of the Nicene Council. To prevent the recurrence of the same error in future, it was ordered that every fourth year should be a leap-year as before, but centurial years, though multiples of 4, should not be leap-years unless they were multiples of 400. The loss of $11\frac{1}{4}$ minutes yearly in time, as computed by the Julian method, amounts in 100 years to 18·6 hours. Calling this one hundredth year a common year gives a gain of one day, or 24 hours, which puts computed time ahead of actual time, $24 - 18{\cdot}6 = 5{\cdot}4$ hours, which, in 400 years, equals 21·6 hours, gain. Calling the four hundredth a leap-

year brings back computed time $24 - 21{\cdot}6 = 2{\cdot}4$ hours behind real time. To lose a whole day at this rate will require $10 \times 400 = 4{,}000$ years.

This arrangement seems simple enough to us now, but it required a convention of astronomers, summoned to Rome for this purpose, ten years to effect the adjustment. This is called the change from Old to New Style. It also changed the dominical letter, which occurred in this wise :

The dominical letter of 1582 was G, and, A being always the letter for the 1st of October, that day must have been Monday, and in regular order the 17th would have been Tuesday, whose letter was C. The change was made by calling the 5th day, which was Friday, the 15th, whence Saturday became the 16th and Sunday the 17th, whose letter we have just seen was C, whence C instead of G became the dominical letter for that year, N. S., and by this all subsequent Sunday letters were regulated. C is the fourth letter in backward order from G, hence the dominical letter of any year, N. S., was four letters backward from the letter belonging to that year O. S., and remained so until 1700, after which N. S. is but the third letter from O. S. because, according to N. S., 1700 is not a leap-year and has but one dominical letter. In O. S. it would be leap-year, and would have two letters. For the same reason, after 1800 N. S. it is only the second letter backward from O. S., after 1900 only the first backward, and so continues until 2100—the year 2000 making no difference, as it is a leap-year in both styles. After 2100, Sunday letter N. S. is the same as that of O. S., and gains one letter each succeeding century, except those which are multiples of four hundred, so that, in every nine hundred years after 2100, the N. S. and O. S. Sunday letter correspond. This furnishes a perpetual almanac.

This arrangement of the calendar, whose complete cycle is four hundred years, is called the Gregorian, from the name of Pope Gregory, through whose instrumentality it was made. It was adopted shortly afterward by all the Catholic countries of Europe ; but Protestant countries refused to adopt it, notwithstanding its obvious superiority and correctness, because it was originated by Catholics. Enlightened public sentiment compelled its adoption in course of time, and an act was accordingly passed by the British Parliament in 1752, almost two centuries later, ordering that the 3d of September should be called the 14th, the error having by that time amounted to eleven days. The change was, however, not popular among the masses, because it changed the time of long-established festivals, and members of Parliament were insulted in the streets by the rabble calling after them : "What have you done with the days?" "Give us back the days you stole!"

We have already seen that tables were constructed showing on what days each new moon would fall in the whole lunar cycle, but,

though they would in nineteen years fall upon the same day of the month, they fell about an hour and a half earlier in the day, and this in sixteen cycles, or about three hundred and twelve years, would make a difference of one day. As these tables were published by ecclesiastical and secular authority, and could not be changed without such authority, another method was resorted to to find the times of the moon without the use of these tables. This method was called the *epact*, which we will now proceed to consider.

The lunar year, as we have already seen, differs from the solar year by about eleven days, i. e., if a new moon occur January 1st of any year, on January 1st of the next year the moon will be eleven days old, on the same day of the next year twenty-two days old, the next thirty-three days old, which equals a whole lunation *plus* three days. This cycle corresponds with the lunar cycle, and is constructed as follows:

Lunar Cycle.	Epact.	Paschal Limits.	Lunar Cycle.	Epact.	Paschal Limits.
1	0	April 13	11	20	March 24
2	11	" 2	12	1	April 12
3	22	March 22	13	12	April 1
4	3	April 10	14	23	March 21
5	14	March 30	15	4	April 9
6	25	April 18	16	15	March 29
7	6	" 7	17	26	April 17
8	17	March 27	18	7	" 6
9	28	April 15	19	18	March 26
10	9	" 4			

From this table the astronomical moons not only for Easter but for the whole year can be found without variation of more than a day for about three hundred and twelve years, at the end of which time the new moon will fall one day earlier, when a new set of epacts must be made, the first of which will be 1 instead of 0, and the succeeding ones will be changed correspondingly. To find the age of the moon for any day of the year, we add to the epact the date of the month, and one for every month from March inclusive, the epact for a year being eleven days, or a day a month nearly. This sum, casting out thirty if required, will give the age of the moon at the given day: e. g., suppose it be required to find the moon's age on Christmas-day of the year 1868. We find, by the method already explained, that 1868 was the seventh year of the lunar cycle, whose epact in the table we found to be 6, to which adding 25 and 10 gives 41; from this deduct one lunation (29 days) = 12 days for the moon's age on that day. The epacts are calculated to show the moon's age on March 1st in any year of the cycle.

The rule for finding the Sunday letter of any year, as given in the "Book of Common Prayer," is constructed upon this principle: The dominical letter of the year of Christ, according to N. S., would have

been B A. Then for any year from 1800 to 1899 the number of letters used equals the number of years + ¼ the number of years (that number being leap-years) —14 for centurial years which are not leap-years. This number divided by 7 gives the number of times all the letters have been used, and if the remainder is 0 the dominical letter is the same as that of the year 0, i. e., A (from March). Any remainders, 1, 2, 3, etc., will give corresponding letters, G, F, E, etc., as in the years 1, 2, 3, etc., A. C. Upon the same principle the dominical letter for the years of any other century can be found. But, as the number to be deducted for centurial years, not leap-years (equal 14), is an exact multiple of 7, the remainder will be the same whether it is deducted or not, and hence no account need be made of it, for it is by the *remainder* and not by the *quotient* that the Sunday letter is fixed. The above-mentioned rule will, therefore, not answer for any century but this one until the twenty-eighth century, when it can again be used, because the centurial number to be deducted will then be 21, which, being also a multiple of 7, may be disregarded.

In addition to these tables, another was constructed showing at a glance what letter corresponds to any day of the year; but, as this table is cumbersome and unwieldy, a device has been substituted which is very simple and answers all the purposes of a table. The letter for the first day of every month is always the same. These letters being known, together with the Sunday letter for any year, we can readily find what the first day of any month is, and consequently what day of the week any other day of the month is. The letters for the first of each are as follows, beginning with January: A, D, D, G, B, E, G, C, F, A, D, F, and, to assist the memory in retaining them, they have been woven into the following couplet:

1	2	3	4	5	6
At	Dover	Dwells	George	Brown	Esquire,
7	8	9	10	11	12.
Good	Carlos	Finch,	And	David	Friar.

SOME NOTES ON A DOCTOR'S LIABILITY.

By OLIVER E. LYMAN.

IT is related, as a legend of the medical fraternity, that the Emperor Augustus was once so highly pleased at a cure effected in himself by his doctor, Antonius Musa, that he raised that gentleman to the rank of knight, and relieved the whole profession from the burdens of taxation.

Probably at no time before or since that event has the lot of the physician been such a happy one. In the earlier days of Rome the

practice of medicine was despised and confined to the humbler ranks of society and to slaves. Not until the influence of Grecian civilization made itself felt in the Roman capital did physicians gain honor or standing.

In the middle ages the calling suffered a relapse, to speak medically. Surgery was in ill repute, and Sprengel tells us that in Germany no artisan would employ a young man as an apprentice without a certificate that he was born in marriage of honest parents, and came of a family in which were found neither barbers, bathers nor "skinners," as surgeons were called.

Even at the present day, although the meritorious claims of the medical and surgical practitioner have been recognized, and an honorable social status awarded him, his mind is not at rest. The advancement and refinement of ideas have begotten deeper anxieties, and a feeling of responsibility. So jealously does the law guard the lives and persons of the people, that every time the physician writes a prescription, or the surgeon makes an incision, he takes his purse, his liberty, or, perhaps, his life in his hand. The risk is not all on the part of the patient, despite a popular impression that the only pocketbook likely to be depleted or the only life liable to be sacrificed is that of the sick man.

In undertaking the care of a patient the physician enters into legal relations with him and becomes a party to a contract, which, although not expressly set forth in writing, is yet, in the eye of the law, fixed and certain, and one which subjects him, in case of a breach on his part, to legal liabilities. He engages that he possesses that reasonable degree of learning, skill, and experience which is ordinarily possessed by the professors of the same art or science, and which is ordinarily regarded by the community or by those conversant with that employment as necessary and sufficient to qualify him to engage in such business. He contracts also to employ reasonable and ordinary care and diligence in the exertion of his skill and application of his knowledge to the matter in which he is employed.*

It is not necessary, in order to sustain an action against him for malpractice, that there should be proof of gross culpability on his part. He is on the same footing, and subject to the same degree of liability, as any other person who is engaged in the performance of services requiring skill and care. Both are equally responsible for a failure to exercise proper care, and for negligence in the discharge of the duty imposed upon them.† But extraordinary care is no more contracted for than the possession of extraordinary skill. If the physician has employed ordinary skill and care in the management of his case, he is not responsible if success does not crown his efforts. But, on the other hand, if he does not bring to the treatment of a disease the ordinary amount of skill possessed by those in the same

* T. Foster, New Hampshire, 460. † 75 New York, 15.

profession, it is immaterial how high his standing may be.* He is liable for the want of it. If, moreover, possessing skill, he undertakes to heal a wound or cure a disease, and through his neglect the party is not cured, or is impaired in health by the treatment, he is also responsible. Behold the two horns of the dilemma which threaten the physician! If he has skill, and neglects to employ it, he is liable in damages; if he has not skill, he is equally liable. The injured party may bring his action to recover for damages resulting from both, and recover, on proving damages resulting from either.

Once having incurred the liability, it sticks like a leech. Retiring from the case is of no avail to shield him against the results of his prior negligence or malpractice. Nor will neglect to send in a bill. Such failure might reasonably be interpreted as an admission of neglect, and as an evidence of consciousness on the part of the physician that he was not entitled to pay, and that his services were worthless.† It has been held also that it is no defense that the services were rendered gratuitously.

This liability is, for the most part, a civil one, and redress can be measured by a monetary standard. If, however, the patient die, and his death is presumptively owing to the treatment received and caused by it, criminal proceedings may be instituted against the doctor, and in such cases the charge of criminal malpractice is not infrequently preferred. Now, the practitioner may never actually have had that malicious or criminal intent which is an essential element of a crime; but, if he has been guilty, for instance, of gross rashness, gross ignorance, gross negligence, or the most criminal inattention,‡ the law very properly infers such criminal intent, and the physician finds himself held for manslaughter. In England the law is, "If one, whether a medical man or not, profess to deal with the life or health of another, he is bound to use competent skill and sufficient attention; and, if he cause the death of the other through a gross want of either of these, he will be guilty of manslaughter." There is nothing unsound in that doctrine.

The physician does not, however, contract for freedom under all circumstances from errors of judgment. The man who possesses ordinary skill is presumed to have ordinary good judgment, and, if it be fairly and conscientiously exercised, and the case is one of reasonable doubt and uncertainty, any errors and mistakes are upon employers alone.

Such is the law in New York. In Maine, however, not so very long ago, a verdict of heavy damages against a physician for alleged malpractice in a case of amputation was sustained on appeal. The Court, nevertheless, expressly admitted that the verdict was found against the defendant on the ground of his error of judgment in not

* 60 Barb. New York, 508. This is a leading case on the subject of malpractice, and the writer has made frequent annotations therefrom.

† 47 New York, 186.

‡ Bishop.

removing more than he did of the amputated limb. Such a verdict is tantamount to saying that the physician ought to have known better what course to pursue, and was therefore guilty of ignorance, on which ground it would, perhaps, have been better to base the verdict than on an error of judgment.

Fortunately for the profession, there are some limitations upon its liability. Ordinarily the physician is supposed to possess a familiarity with the characteristics of the dominant disease. As it has been summed up: "His diligence and care will be exercised in watching for and guarding against the numerous accidental influences which, if overlooked, may delay or even prevent the restoration of the patient, such as latent predisposition to certain diseases; a lack of vital or recuperative power in the patient; the effects of melancholy and of other passions of the mind; the effect of the want of pure air and good food; of careful attendance and nursing; the neglect of the patient to follow the physician's advice, or to take the medicines which he prescribes."

A surgeon once, in a case of dislocation of the elbow-joint, replaced the bones and put the arm on a pillow; with the part below the joint at a right angle with that above it, and directed the application of cold water, but omitted to give warning that the arm must remain in that position. Assuming for the moment that such treatment was enough, the Court declared such omission to be culpable negligence on his part. Had he, however, performed his task skillfully, omitting nothing, and then the patient had neglected to comply with his directions, the surgeon's liability would have been limited. For in the case of the sane it is the patient's duty to coöperate with the physician or surgeon, and conform to necessary prescriptions. If he will not, or under pain can not, his negligence is his wrong or misfortune, for which his physician is not responsible.*

If the patient's neglect to obey the reasonable instructions of his medical attendant, contributes to the injury complained of in an action for malpractice, he can not recover.† Contributory negligence is a good defense, and in this respect the patient is "on all-fours" with the man who is run over while walking on a railroad-track without authority. Neither can recover. While there may have been negligence on the part of the engineer or the doctor, yet, the pedestrian and the patient being equally at fault, no recovery can be had. But, if the patient has neglected to use necessary precautions, because lulled into a sense of security by the doctor, the doctor will be liable. A refusal, however, on the part of the patient, to prevent an attempt to remedy the injury already caused by malpractice, does not necessarily preclude a recovery, if the refusal was made without reasonable assurance that the attempt would be successful.‡ And it would seem that refusal,

* 22 Pennsylvania Statutes, 261, 7 Phil., 138.

† 25 Ohio Statutes, 86.

‡ 68 Pennsylvania Statutes, 168.

even after assurances of success, would be just and proper. What weight have assurances from a negligent physician? Is there any reason to suppose that, after having broken his implied contract for care and skill, he is in any better condition to observe his express one? But, if the physician guarantees a successful issue out of the trouble, he will be held responsible in case of failure to effect a cure, although, ordinarily, he would not be liable if he had employed such care and skill as were above spoken of.

The discussion of this question of responsibility opens up the ancillary and possibly more interesting one, how far can the physician or surgeon deviate from the established rules of practice without being charged with negligence in case of an injury to the patient arising from such deviation?

An English judge says, "Any deviation renders him liable."* This is rather severe, and, if practically applied, would effectually bar progress in the practice of physic and surgery. Every practitioner would be as antiquated as a Galen or Hippocrates, and the sick and diseased would lose all the benefits and improvements which the experience of years and the researches of science furnish. The rule works a hardship. In striving for protection, it causes deprivation. American authorities introduce a modification. If it is shown that physicians or surgeons have applied a different system of treatment and found it to succeed as well as or better than the one prescribed, it is not negligence, so says a New York judge, to resort to the system thus practically tested. In other words, one can not become an experimentalist, except at his peril. If a writer on treatment, or, in the absence of such authority, practical surgeons prescribe certain grooves, in those grooves he must run. But, if others have previously taken the risk and been successful in a new line of treatment, it may be followed with impunity, and will shield the practitioner from the charge of malpractice, provided that the cases in which it was tested were substantially the same as those treated of by the writer or by the practical surgeons, and provided the treatment thus resorted to has been successful to such an extent as to leave no doubt as to the propriety and safety of adopting it. If the case is a new one, the patient must trust to the skill and experience of the physician he calls in. So also must he, when the injury or disease is attended with injury to other parts, or other diseases have developed themselves, for which there is no established mode of treatment. There can not but be some cases when latitude must be allowed the physician in the application of remedies. But, when the diagnosis reveals a disease for which there is a well-established method of treatment, the practitioner departs from it at his risk.

This rule is for the best welfare of the community. It protects against reckless experimenting, while it permits the adoption of such

* 2 Espinasse, N. P., 601.

changes as have been thoroughly tested and their benefits demonstrated. It is also quite in harmony with the spirit of the profession, which may, perhaps, in the phraseology of the day, be said to be "conservative—not too conservative, but just conservative enough."

Men who profess to deal with human life and health adopt radical changes with cautiousness. Yet the members of no other profession, probably, are more ready for discussion. Theories are constantly advanced and—upset. Others are maintained and imperceptibly shaded off into practice. Galen was an authority for thirteen centuries, when a revolution of medical ideas took place, and his works were burned by Paracelsus and his followers. The homœopathic offshoot of what is known as the regular school of medicine obtained a foothold only after years of debate and discussion. It is only a few years ago, in 1855, that a judicial decision was necessary to establish the right of a homœopath to the title of doctor,* and it is not so very long ago that an allopath thought he could call a homœopath a quack with impunity. In a slander suit in which he was a party defendant, the Court, however, convinced him of his mistake.†

This incident illustrates the disposition of the older school toward innovations and the vindication by *one* new branch of practitioners of its claim to recognition. But, surprising as it may seem, such were the statutes in force in New York State from 1844 to 1874, that all other classes of practitioners were equally countenanced by the law. Allopath, homœopath, hydropath, or whatever devious path he followed, the man who made the practice of physic or surgery a business was entitled to the name of doctor, and to the protection afforded by the courts.‡

A *résumé* of the statutes which have been passed in the Empire State regulating the practice of physic and surgery reveals a most curious struggle against quackery, in which it will be seen that quackery was for the most part triumphant. About the beginning of this century our law-makers undertook a reform in the matter of practice of physic and surgery, and made it a penal offense to do either without being duly licensed for the purpose. There being no enactment in special terms against the recovery of compensation for such unlawful services, the Legislature, in 1806, passed another statute expressly declaring that any person who should commence practice without a license, after the first day of September next ensuing, should "for ever thereafter be disqualified from collecting any debt or debts incurred by such practice." This was a severe blow to "quacks." It was penal for them to practice, and they had no friend in the Court. Truly, the way of the transgressor seemed hard. The bonds were carefully examined and readjusted in 1813. The revision of 1830 contained similar provisions. The unauthorized practice of physic and surgery was declared "a misdemeanor punishable by fine or imprisonment, or both."

* 4 E. D. Smith, New York, 1. † 42 New York, 161. ‡ 4 Denio, New York, 60.

This provision was short-lived. The work of the lobbyists of the irregular party began to tell. In April of the same year an act was passed which made the offense penal instead of criminal, and which also declared that such penal provisions should "not be deemed and taken to extend to or debar any person from using or applying for the benefit of any sick person any roots, barks, or herbs, the growth or produce of the United States." Mark the charming protective air in that statute! Under a free construction it reads, "However dangerous they may be, if you only use *American* roots and products, we don't care what you do." Quackery was again the upper dog. But the struggle was not over. Although on top, the other dog had a vicious grip upon him. The empiric was still unable to recover compensation from delinquent patients. He was equal to the emergency, and took his pay in advance. It took the licensed practitioners four years to make the next move, which was a feeble one. In 1834 the exemption from the penalty was confined to such as used the herbs, etc., without fee or reward. The next year the enactment was blotted out, and the two parties stood as in 1830. For fourteen years the condition of affairs remained unchanged, when, in 1844, all criminal and penal laws against the unlicensed practice of physic and surgery were repealed, as well as every enactment which prohibited any person from recovering compensation for services as physician or surgeon, whether licensed or not. One doctor was as good as another in the eye of the law. Quackery had achieved a complete victory, and was liable only in cases of malpractice, or gross ignorance, or immoral conduct in such practice. The standard of admission to the profession was lower even than it was in the time of the Christian emperors. At that early day physicians were required to undergo an examination to prove their competency to perform professional duties before they were permitted to practice. If any practiced without a license they were heavily fined.

For thirty years the situation remained unchanged. From 1844 to 1874 no step was taken to purify the system. But, in the latter year, our legislators awoke. Among other regulations it was declared "a misdemeanor for any person to practice medicine or surgery in the State unless authorized so to do by a license or diploma from some chartered school, State board of medical examiners, or medical society," or who should practice it "under cover of a medical diploma illegally obtained." The punishment was to be a fine of not less than fifty dollars nor more than two hundred dollars for the first offense, and for a subsequent offense a fine of not less than one hundred dollars nor more than five hundred dollars, or imprisonment of not less than thirty days or both. This was an excellent move, and, supplemented by the one in 1880, has been fairly effectual in driving out unlicensed practitioners. The enactment of 1880 provided that no person shall "practice physic or surgery within the State unless he is twenty-one years of age, and either has been heretofore authorized so to do pursu-

ant to the laws in force at the time of his authorization, or is hereafter authorized so to do," either by a license from the regents of the University of the State of New York, a diploma of an incorporated medical college within the State, or a diploma of a similar institution without the State, provided it be endorsed as approved by some proper medical faculty of the State. But every physician and surgeon, with the exception of practitioners of ten years' standing and a few others, must register in the office of the clerk of the county where he is practicing, or, if hereafter authorized, intends to practice, his name, residence, and place of birth, together with his authority to practice, to all of which he must subscribe. He must also make affidavit as to the manner of his license or authority, the date of the same and by whom granted, which, if willfully false, shall subject the affiant to conviction and punishment for perjury. Any one who violates either of these provisions or the one in regard to practicing, or who shall practice under cover of a diploma illegally obtained, shall be deemed to be guilty of a misdemeanor, and on conviction shall be punished in a similar manner to that provided in 1874.

Such is the law at present in New York State. Much has been accomplished, but something yet remains to be done. There are weak points in the laws, noticeably the exemption from the operations of the act of 1880 of ten-year practitioners. While this may have been inserted to save reputable men from unnecessary trouble, does it not also leave a foothold for a disreputable class of an equally long standing? It is true, the law of 1874 is in force, declaring unlicensed practice to be a misdemeanor; but its inefficiency in meeting the evil necessitated the move of 1880.

The profession, however, is in a fair way to be purged of most that is foul in it. Perfection is not a mortal attainment. Let the community, then, be thankful for its present measure of protection. Against "quacks" our Legislatures are working. For malpractice the courts furnish redress.

ORIGIN AND STRUCTURE OF VOLCANIC CONES.

By H. J. JOHNSTON-LAVIS, F. G. S.

I.

OUR general ideas of its appearance, if we have never seen a volcano, differ considerably from what we find when actually brought in contact with one.

We always have the tendency to associate a mountain as the site of volcanic outbursts. Such is the case in general rule, though with many exceptions. In fact, the variations are so great that in many cases we should be inclined to attribute the extreme forms to totally

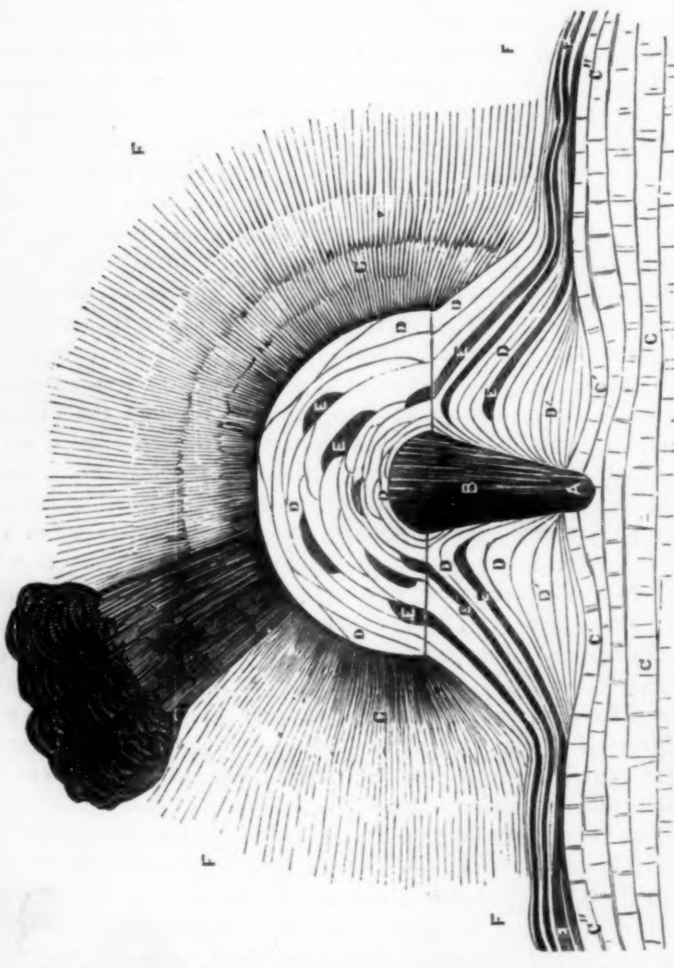
different origins, were there not existing intermediate ones which demonstrate that they are all varied modifications of one almost uniform series of physical effects.

Thus to one looking first at the vast volcanic cone of Cotopaxi, almost perfect in form, and comparing it with the ring-like cavity of Astroni in the Phlegrean field, it would be almost incomprehensible to believe that these two extremes are the result of identical forces acting much in the same manner and producing such widely different effects. But in the latter district we have not to travel far to find other vents that act as interpreters in explaining these variations of forms. In the present paper it will be my endeavor to explain the building up of what we will call a normal volcanic cone, and then afterward to point out the extreme variations to which such a mass is liable.

Given a large volume of heated vapors and liquid rock that has burst its way upward through the subjacent strata, in what way will it manifest its presence, and what traces will it leave behind? This vapor does not seem to exist separately from the molten rock or lava at any great depth, but as it approaches the surface the enormous pressure is reduced, the water and other gaseous matter expand, separate themselves into little bubbles scattered through the highly heated liquid magma. These will collect, to a certain extent, and from their lightness will float to the surface of the lava and there burst. The vapor may have commenced to form at great depths, and in its upward journey have become exceedingly bulky, so when it reaches the surface it would escape with a loud explosion. If we watch lava in the crater of a volcano in a quiescent state, such as Vesuvius, we see these great bubbles, so to speak, continually forming and bursting. As they burst, the surface of the vesicle is blown up as soft, pasty fragments, to the height of many feet. These masses appear black by day, but red-hot by night; they may cool or not, before falling; if the latter, when they strike the ground, they adapt themselves to the irregularities of the surface, and form, as it were, a cast thereof. This condition is much exaggerated at the first outbreak of an eruption; the vast column of fragments often reaches an altitude of two and three thousand feet. There the pieces ascending meet those descending, and so there is a continual grinding going on between them; the fine dust is taken by the wind and transported often many miles, forming the so-called clouds of volcanic ash. The larger fragments (or *lapilli*, as they are named) may again fall back into the opening or around its edge, thus building up an annular bank. This is really the foundation of the cone.

If we speculate for a moment on the formation of such a heap, we shall see that the first strata deposited will be horizontal, but somewhat thicker toward the axis of explosions. (See D, diagram.) This, however, as the action continues, will begin to arrange itself in a

direction slanting away from the axis, until the beds reach the maximum angle of repose of the rock-fragments in question as the beds (D D) on diagram. Thus we have constructed a conical mass in the center of which is the volcanic chimney (B), and, dipping away on all sides at angles, varying generally between 20° and 45°, we find the strata composing the cone (D, E). This arrangement is often called



DIAGRAMMATIC BIRD'S-EYE VIEW OF A VOLCANIC CONE.—The upper part is supposed to be removed by an horizontal section, and one half of the remaining base by another longitudinal one. A, vent; B, chimney; C, basement rock, compressed downward at C′ and upward at C″; D, ash-beds; E, lava streams, one of which, E′, is seen to have run down the slopes, G, of the cone, and spread over the plain F.

periclinal. The funnel, or chimney, which has been mentioned as occupying the center, has the form of an inverted cone, the inclination of its sides and its diameter necessarily being proportional to the volume and force of the escape of vapor, and also to the nature, form, and size of the surrounding fragments, forming the growing cone, which have already been ejected. The upper, or basin part, is technically called the crater. The vapor only may have made its appear-

ance at the surface, and in fact may have parted company with the lava at very considerable depths.

Or the latter may have been forced up almost simultaneously with the vapor, and poured out over the edge of the primitive cone. This, however, is not the general rule, for an escape of much gaseous material nearly always precedes for a variable period the appearance of the lava. In fact, when a volcanic outburst has forced a convenient passage for the vapor, the exit of liquid rock seems of secondary importance, for generally the terrific explosions, earthquakes, and subterranean thunder that accompany the first stage of eruption are more or less absent, or at least much diminished during the welling up of the fluid rock. If, as in the latter case, a cone of some considerable size has been formed, the lava will rise and occupy the whole of the crater-cavity. Two things may happen: If the cone which now forms, as it were, an embankment around the lava is of sufficient strength to withstand the pressure of the fluid mass contained within it and the continual explosive vibrations, the liquid rock pours out over the edge of the crater down the side of the cone, and may continue its course for variable distances from its starting-point; or if, on the other hand, the cone is too weak to support the strain, it may break away and give free passage to the lava through the breach. This condition is well illustrated in many of the Puys of central France. There is another series of events, that is to say, the formation of dikes, about which we shall have more to say anon.

The lava may form a series of little streams over the cone sides, changing their situation according to the point at which the crater is lowest. Here it will cool, forming a buttress of rock on the slopes of the cone. These masses will be covered again by *lapilli*, other buttresses formed in the same manner, and thus the cone built up higher and made stronger. If we see it in section, as in the diagram, it will present a stratification of alternate beds of rock and cinders. This, however, is misleading. The lava-streams do not form a continuous sheet surrounding the cone—see diagram, where they are seen cut through in transverse section. When a mountain of some height has been formed, it then becomes liable to fracturing, and the formation of so-called volcanic dikes. Mr. Mallet, in a communication to the Geological Society,* thoroughly explained this condition of things. As we have seen, the cone may form an embankment around the column of lava occupying the chimney and crater, consequently there is an enormous pressure put upon the supporting wall of loose material. Let us begin by taking the pressure of a column of water thirty-two feet high, then let us say another four thousand feet, roughly the altitude of Vesuvius, and compare that with a column of molten lava, whose specific gravity is two or three times that of water. This would be an interesting calculation: given the specific gravity of

* "Proc. Geol. Soc.," London, vol. xxxii, part iv, p. 478.

Etnean lava, the height of the crater, what is the unit of pressure at the sea-level?

The outward pressure of the lava will increase in proportion to the depth. Also the cone wall necessarily increases in thickness from above downward. This, therefore, tends to counteract the augmentation of pressure from within. Nevertheless, when this is so great inside that the inner layer of the chimney must necessarily be compressed outward, and therefore the circumference made larger, the consequence is that at one point it begins to yield, forming the commencement of a perpendicular fissure, radiating from the central axis, and, by the same course of circumstances, this will gradually spread outward. Mr. Mallet,* in his paper describing these mechanical effects, aptly compares them to the bursting of a gun where the greatest strain is on the inner lining, and consequently the fissure commences in this and radiates outward. In a volcano, as the fissure is formed, it is immediately occupied by the fluid lava. If the fracture extends far enough it may reach the surface, where it may form one or more parasitic cones. By the explosion of vapor from the lava, these cones are generally formed in a row, radiating from the mountain axis, and in a step-like arrangement. This is attributed to the fact that, as the lava and vapor escape, the former reaches a lower level, and here forms the second, third, fourth, and so on in succession. This was well illustrated in 1861 at Vesuvius, where seven such hollow mounds were formed, the first being the largest, and gradually diminishing downward, as the igneous forces became exhausted. The pressure of the contained fluids may be so great that the entire side of the mountain may be rent asunder with the rapid escape of the contained lava, thus forming a breached cone. In the above-mentioned paper,† in fact, it is supposed by the author that all such have originated in this manner. A third condition of things may be brought about: this fissure may only extend a certain distance from the chimney, never showing itself superficially, and the lava occupying the fissure will gradually become cooled and consolidated, forming a perpendicular sheet of rock or dike, as it is called, radiating from the mountain axis. These are well illustrated in the Val de Bove of Etna and the escarpment of Monte Somma. In the former,‡ Sir Charles Lyell adopted the plan of endeavoring to find the orientation or point of convergence of these dikes, to localize the site of the old crater supposed to have produced this curious cavity. This was followed by the untiring work of Mr. Mallet in the latter locality, to determine where the axis of Somma should be placed. In the latter case twenty-seven of the largest were chosen, but, when their directions were taken by a careful survey, they were found not to converge at one point, but in some there were discrepancies of upward of two

* "Proc. Geol. Soc.," London, vol. xxxii, p. 478. † Ibid., vol. xxxiii. p. 740.
‡ Sir C. Lyell, "Lavas of Mount Etna," "Phil. Trans.," 1858.

kilometres between the points of melting. This we can well understand when we know how irregularly the cone is constructed, and how buried *coulées* of lava may derange the direction of the fracture, such as we exaggerately see illustrated in some old denuded trap dikes, threading their way along planes of least resistance. There is another source of error—that is, that so little of the projecting edge of the dike is exposed to accurately take its strike, thus rendering us unable to determine by this means the locality of an old volcanic axis.

If we look at the figure, at the surface C′ C″ of the subjacent rock, we observe it forms a wave-like line in section. It is again to Mr. Mallet* that credit is due for the explanation of this somewhat anomalous appearance. It is known that the ground under high towers and other heavy structures is gradually compressed by the immense superincumbent weight. At the same time a corresponding elevation takes place around the base of the structure. This is just what occurs in a volcanic mountain. The immense pressure of superposed material compresses, to a variable degree, the subjacent rock, according to its yielding power. This will be greatest where the column of materials is highest, that is to say, exactly under the crater edge as at C′, in the diagram. This causes a corresponding rim-like elevation around the base, or at the toe of the cone as at C″, in the diagram.

The materials which go to form the cone are the subjects of our next consideration.

Taking as our standpoint the old but useful division of lavas into basaltic or basic, and trachytic or acidic, let us look at the characters presented by these two great classes of rocks. Basalt and its congeners are generally heavy, compact, dark-colored, more or less crystalline. Very rarely vitreous in structure, and only in small patches. Excessively fluid in the molten state, losing heat and fluidity slowly, and then passing rapidly from the liquid to the solid state, the liquid fragments of which, when ejected from the crater, generally fall still plastic, and, when cold, form an excessively ragged, hard, angular mass. The surface or scoria of the lava-stream also is hard, and not easily broken, the main mass itself being very apt to form the well-known columnar structure. On the other hand, the trachytic or acidic lavas, when molten, are very viscid, which condition increases rapidly as it loses its heat, so that it flows very short distances, often stopping midway down the steep side of the cone, as in the island of Vulcano, or forming a large, boss-shaped mass around the vent.† When cooled slowly it crystallizes, but it is much more liable to form a vitreous mass or obsidian than the basaltic rocks, resulting probably from its high percentage of silica. In fact, it behaves very much like glass or slag in its physical transformations. As on the surface of the glass pot is

* R. Mallet, F. R. S.: "Hitherto Unnoticed Circumstances affecting the Piling up of Volcanic Cones" ("Proc. Geol. Soc.," London, p. 740).

† P. Scrope, F. R. S., "Volcanoes," 1862.

formed a frothy-like mass which cools as a light, spongy, vesicular material, so by the explosions from a trachytic volcano, similar masses are formed and thrown out, well known as the useful pumice-stone. This variety of lava produces often a very ragged surface, much less durable to mechanical agents than that of the other class. Again, it is very light, often more so than water. These differences, of course, merge into one another, lavas often occurring that are not easy to classify; but for our purposes the extremes are more suitable of illustration. Also, the same volcano may at different periods have yielded successively each of the varieties of igneous matter. Vesuvius, for instance, has ejected materials of each of the classes, and many distinct varieties of the basic. Obviously the discordance of these physical characters must necessarily produce considerable distinction in the physical conformation of a volcanic region in general, and of the cone in particular. It may be our want of a thorough examination, but it is apparently the rule that dikes are much less common among the trachytic volcanoes than the basaltic, whereas, apparently the largest number of breached cones belong to the former, thus contradicting to some small extent Mr. Mallet's * dike theory already referred to. Thus we see that all the solids so far derived from a volcano, lava, scoria, lapilli, ash, etc., are all mechanical modifications of the one molten rock. There is, however, another important factor of which we have not spoken, the so-called ejected blocks. These are nothing more than fragments of the solid rock walls of the volcanic chimney or vent. They, therefore, vary according to the rock through which the igneous outburst has occurred. Thus we find among the constituents of the Vesuvian slopes a great variety of such blocks, among which the beautiful minerals yielded by Somma are found. These may be roughly divided into three classes :

1. Limestone variously metamorphosed, derived from that like Castellamare, which dips under and forms the Vesuvian platform. These fragments are sometimes so altered, by the intense heat, pressure, and chemical action to which they have been subjected, that it is only by studying the intermediate varieties that their origin can be detected. It is these blocks that are richest in the Vesuvian minerals.

2. Calcareous mudstones containing late pleistocene fossils, these being in a very perfect condition, containing generally a great number of well-preserved leaves. This rock is curious, as being of apparently (though not real) volcanic origin, and containing marine fossils without submergence.

3. Trachytic and corresponding tufa, also basaltic tufa. These are also masses of highly micaceous feldspathic rocks, that probably are nothing more than the excessive metamorphosed condition of the first class.—*Science Gossip.*

* "Proc. Geol. Soc.," London, vol. xxxii, p. 478.

MAN AND THE VERTEBRATE SERIES.

By CHARLES MORRIS.

MAN stands as a connecting link between two worlds—the world of matter and that of mind. He forms the apex of the development of matter, the loftiest effort of evolution in substance. Mind, it is true, has its foundation in the regions of life below him, but all its superstructure—the towering arches and lofty pinnacles of the ideal—rests upon the human intellect. Man thus forms the gateway which Nature has placed between her two vast kingdoms of substance and thought, and in the human brain these two realms meet and merge, energy flowering into intellect, substance into soul.

But is the human form the true culmination of the development of matter? Has Nature really reached in man her acme in this direction? A deductive philosopher would perhaps answer this question in the affirmative, on the theory that Nature would not stop short of the most completely developed physical form, as the starting-point of mental evolution. He might claim that a perfect soul could only arise in a perfect body, and that, as Nature is striving toward perfection, she must lay all her foundations at the highest possible point.

But inductive science starts with no theories. It builds its theories out of facts, not its facts out of theories, and follows Nature upward from her roots, not downward from her branches. What, then, do the facts of Nature say as to the question of animal evolution? Is man truly the paragon of animals?

Unfortunately, this question opens before us a field of investigation too broad for consideration in a single article. We have already seen that Nature has exposed organic forms to an almost unlimited variety of conditions, during the long geologic ages, and has probably tried every line of development of which organic life is susceptible. By a close review of the various animal types, their advantages and deficiencies have been traced, and we think it has been shown that the vertebrate type is the one suited to the highest evolution, and the one toward which all the lower forms tend in their highest representatives.*

For a complete review of organic form development the plant types should also be considered, but we must confine ourselves in this article to a consideration of the vertebrate type of animals alone.

And first, What are the causes, what the modes, what the laws, of evolution? What features in one animal constitute superiority to another animal? These questions we shall but briefly answer. There are certain requirements absolutely necessary to the continuance of

* "Evolution of Organic Form." "Popular Science Monthly," November, 1880.

animal life. One of these is a sufficient supply of food ; a second, a sufficiency of oxygen ; a third, proper nutritive and excretory organs ; a fourth, proper reproductive powers.

The first and fourth are of most importance in this connection, for they are in constant conflict with each other. The quantity of available food is far more limited than are the possibilities of animal increase. Necessarily, then, the latter is restricted by the former. A crowding-out process ensues, and only those best adapted to obtain food survive.

But an equally necessary result is an adaptation to new sources of food, one of whose earliest consequences is the production of carnivorous animals. Thus the crowding-out process becomes, in part, an eating-out process. The animals thus exposed to destruction would necessarily be at a marked disadvantage in the race for life, were not some protection provided them. For safety they need weapons of defense or means of escape. It all comes to this, then, that the strongest, swiftest, best-armed, and most alert animals will survive, these qualities enabling herbivora to escape their foes, carnivora to overcome their prey.

But there are two ways in which this survival may be attained : one by adaptation to a few simple conditions ; the other by adaptation to many and complex conditions. The wider the scope of adaptation in an animal, the greater is its functional complexity, and the higher its organic position, as compared with the more simplified tribes.

Still another requisite of the utmost importance is the principle of division of labor. No organ can do two distinct things equally well. If forced to perform two or more labors, there must be a degree of imperfection in its work, or its ability in each direction must be greatly limited. Therefore evolution is in the direction of separation of labor, each organ tending to become confined to one kind of work, to which alone it becomes adapted, but in which it produces better and wider results.

Seeking, then, for the features likely to distinguish the most highly developed animal, we may safely say that they will appear in that animal exposed to the most complex conditions, adapted to the greatest variety of food, possessed of the most fully specialized organs, capable of using its innate forces to the best advantage, and commencing its individual existence with the best start in life.

With this preliminary we may proceed to a closer investigation. Vertebrate animals occupy every kingdom of nature—the sea, the land, and the air—but not under equally advantageous conditions. The inhabitants of the sea, for instance, are exposed to decided disadvantages, and lack certain important incentives to development. Their vital activity is necessarily much below that of land-animals, from the limited quantity of oxygen obtainable by water-breathers as compared with air-breathers. Their sensory acuteness, also, is less developed. Light comes to them dimmed, sound comes to them dulled, the

water which surrounds their food must blunt the senses of taste and smell, and there is little besides water contact to develop touch.

Also the conditions surrounding attack and escape are here greatly simplified. The water presents no lurking-places, no ambush, except to the inactive dwellers upon the sea-bottom. And, by relieving its inhabitants from the effects of gravitation, it renders rapid motion easy, with slight muscular exertion. Thus the easiest, most natural, and most effective means of assault and defense is by swift powers of swimming.

The same principle holds good in the case of the dwellers of the air. There is here no lying in wait for prey nor hiding from assault. Flight is the most effective and most ready means of attack and escape, and the only one available in the fields of open air. Thus purely water and purely air animals fail to develop a variety of resources in this particular.

Moreover, as fish are at a disadvantage from their imperfect oxidation, so are birds at a disadvantage from the effects of gravitation. The weight of fishes is almost or entirely supported; that of land-animals partly supported; that of birds almost unsupported. Gravitation in them, then, must be mainly overcome by muscular exertion. Thus a large proportion of their life-force is exhausted by the effort to sustain themselves against the constant downward pull of gravity. This places them at a disadvantage with animals capable of using their forces for more varied purposes.

Indeed, we find, both in fishes and in birds, a tendency to avail themselves to some extent of the advantages which the land-surface gives. And those that most display this tendency comprise the species of most varied resources, and with the greatest degree of functional adaptation. Many species of birds, in fact, have found safety so much more assured on the land, that they have lost, first their instinct, and then, in some cases, their power of flight, and have become, virtually, surface-animals.

We may descend to the invertebrate world for one marked instance of this. The ants are acknowledged to be the highest of all insects in functional development. Their eyes, for instance, are more simplified than those of other insects; and, if we class mental attributes as nerve-functions, their claim is indisputable. Yet they have forsaken the air and taken to the earth in preference, the females casting off their wings as if in scorn, after a temporary use of them.

Of all the fields of life for the varied display and functional separation of the animal forces, we are thus brought to the land-surface as obviously the best. Here an abundant supply of oxygen assures vital activity; the firm ground largely supports the weight, and releases the muscular powers for employment in other directions; the abundance and variety of vegetable food sustains vast numbers of animals; the great diversity of conditions causes wide specific variation; while

the simplification of modes of assault and defense in water and air is replaced here by the most varied motions, such as creeping, running, leaping, climbing, etc., by a diversity of ambushes and hiding-places, and by the necessary adaptation of carnivora to numerous modes of attack, and of herbivora to as numerous modes of escape.

In fact, the specific variations in birds spring from their relations to the surface. Here, as a rule, they seek their food. Here their mental powers arise. Here they develop other functions than flight, other organs than wing-muscles. And it may be that the variations in the fish type spring principally, in like manner, from their relations to the sea-bottom, and the adaptations of carnivorous fish to the powers of escape of forms thus varied.

Thus in the process of animal evolution we reach the dwellers upon the land as the most developed, and the best situated for further development. Those land-animals that retreat to the other fields of life retrograde in consequence. The whales have gone back in their functional development until, in many points, they are affiliated with the fish. The bats have sunk toward the bird-level. So the lowest in function of land-animals are those which retain close affinities with the air and water life of their ancestors, or have but lately migrated to the land. The wingless birds are low in mind and in animal function. The amphibia rest at the lowest level of land-animals. The reptiles are but a step above them.

In the latter class, it is true, there are many which have long broken loose from all connection with a water habitation. Most notable among these are the serpents. But the latter, from their habit of seeking safety in concealment alone, have retrograded functionally, their limbs disappearing, and their bodies being extended prone upon the earth. This location, while an undoubted advantage as affording concealment, is a disadvantage in development. The prone condition of the serpent has caused its limbs to disappear, as useless. Its ribs have taken the place of limbs, and the body has extended in length sufficiently to increase the number of these imperfect limbs, and thus render them more available for motion. Its sensory organs have necessarily become less acute from the disadvantages of position. Gravitation is largely overcome, by the full support of the body upon the earth. But it is replaced by a friction which is equally disadvantageous.

Thus, if we would seek the type of land-animal most likely to develop functionally and mentally, we must look in an opposite direction to that taken by the serpent. The protection that is gained by concealment is a retrograde form. The animals that advance most rapidly are those that are least protected, either by powers of concealment, of flight, or of muscular vigor.

For what does development mean, in its true sense, but extended experience of nature? The greater and more varied the experiences

attained by any animal, the best suited it is to cope with nature. And if this variety of experiences extend through the life of a species, it becomes adapted to escape from more varied descriptions of peril and to obtain food in greater variety and quantity.

Thus, in seeking the form of animal most fairly planted in the path of true development, we must look for one capable of attaining to wide experience of nature, and adapted to evade perilous or to take advantage of beneficial conditions of the most diverse character.

These considerations lead us to a conception of the description of animal most likely to appear as a development from the low amphibian and reptilian forms. It must have sensory organs acutely adapted to all of Nature's most active forces, as light, heat, sound, and contact in its several kinds. It must be elevated above the surface sufficiently to give it the widest range of vision and hearing, these most important of the perceptive powers being specially active at the highest elevation of the body. It must rest upon the earth in such a way as to reduce friction to a minimum, so far as is consistent with proper support; and its powers of flight, of concealment, and of physical strength, must be sufficiently reduced to force it to seek other sources of safety, to adapt its organs to more varied functions, and to develop new features of mental activity.

What will be the form and the conditions of exposure to and defense from danger, of this most highly developed animal, adapted to gain the widest experiences, and to the greatest organic division of labor? It must, of necessity, display in its evolution every intermediate gradation of form upward, from that of the lowest vertebrate. Its form must be founded upon that natural to the fish.

Now, the fish naturally and inevitably assumes the horizontal posture from the requirements of its mode of life. It has developed fins as organs of movements. The fin is, in fact, as closely adapted to the fish-form as the oar is to the boat-form. The vertebral fins are reduced in number to four. There is a decided advantage in this reduction, in the saving of muscular exertion needed to move the fin, and also of the weight of extra muscles and fins. But a smaller number than four would be a disadvantage in the varied movements requisite to safety.

The fish-body is necessarily narrow and long, so as best to avoid friction. For its most effective movement it must be properly balanced, its two sides being alike in form and equal in weight. This produces bilateral symmetry of form, and perhaps also of organs, equal weight being most easily and completely attained by a reproduction of organs on the opposite sides of the body, but flexibility and full control of such a long, narrow body could not be gained except by a separate power of motion at each extremity and at each side. Therefore adaptation tends to produce in it four fins, and four only—an anterior and a posterior one on each side.

The fish-form governs that of the amphibian and of the reptile. The fins become limbs, which are variously modified. In some amphibians, as in the frog, the limbs become different in functions, the hind-limbs being adapted to a leaping motion, the fore-limbs to support. A differentiation of another kind takes place, eventually, in the reptile stock, the fore-limbs becoming organs of aërial support. They become wings, and we obtain the bird type, with fore-limbs adapted to aërial, hind-limbs to solid support.

These, however, are but aberrations from the general path of development, which is toward a continuance of the horizontal position of the fish-body: the fins become four similar supporting limbs.

Adaptation from this point takes one general direction, that of the reduction of weight to the lowest point consistent with the proper exercise of the nutritive functions, and the requisite strength of bone and vigor of muscle. The general shape attained by the body is governed by several mutually assisting or opposing functions. The requirement of speed needs that it shall be narrow and long, so as best to avoid the resistance of the air. But too great elongation would be a disadvantage, since the mid regions of the body would remain without support by the limbs, and could only sustain themselves by muscles acting to oppose gravity. These muscles would add to the weight, and would form additional consumers of force. The best form of the body, then, is one sufficiently narrowed to partly avoid aërial resistance, but not so elongated as to diminish its proper support upon the limbs. The chief aberrations from these requirements are those of the prone serpents, and, among mammals, of the weasel family, whose mode of life requires a very narrow body, so that digestive space can only be gained by its elongation. We may return here to the serpents to say that their elongation is probably due in great part to the same cause. Their mode of concealment and of motion requires great narrowness of body, so that space for the nutritive functions can only be gained by elongation. The requirement of narrowness is, in fact, so great that there is not sufficient room for the larger organs to be bilaterally reproduced, therefore respiration is confined to a single lung, the other being atrophied.

But, with a comparatively few exceptions, caused by highly specialized life-habits, the land vertebrates possess the general form requisite for the fullest adaptation to these three conditions—that of reduced resistance to motion, proper support, and the necessary room for the exercise of the nutritive functions.

The weight of the body is reduced to the lowest possible limit consistent with its general size and the exercise of its functions. The limbs, for instance, take no part in the nutritive function, and are reduced in size to the weight of bone requisite for support and of muscle necessary to move the body. The head is just large enough to hold the brain, the organs of special sense, and the mouth with its

organs. The neck is narrowed to a mere covering to the œsophagus, the vertebræ, and the muscles of head-support. Its necessary flexibility is one reason for this, but the cutting off of extra weight wherever it can be spared is another.

Thus, as a general result of these evolutionary principles, we obtain a body of horizontal shape, supported upon four limbs, and reduced in weight and in elongation so as to give it the best possible control of its motions, and the greatest agility consistent with its necessary gravity.

The necessity of quick knowledge of danger and of ready escape from it have had other equally important results. The organs of sight and hearing has been placed at an elevated point, so as best to perceive distant danger, while the limbs of the herbivora have also elongated so as to lift the body to a wider outlook. This elongation of the limbs is also an important adjunct to rapid flight, so that there are two forces at work upon its development.

In the carnivora, on the contrary, the crouching, springing habits have tended to shorten the limbs, and to adapt them to vigorous leaps instead of to rapid running movements ; to a life in ambush instead of to a life in action.

But the particular features of the body of the land vertebrate are as closely a result of natural requisites as are its general features. It forms, in a large sense, a digesting and assimilating machine, the force derived from assimilated food being largely applied to the muscular and nervous functions needful to obtain new food, or to avoid danger. Another portion of this force is applied to excretory and reproductive functions. That is all. There is none of the human employment of force in abstract mental conception. All mentality in undomesticated animals is employed in the art of self-preservation.

The organs arise as direct consequences of these necessities. We may view them as partly governed in position and character by their descent from the fish type ; yet such a controlling agency hardly appears, so exactly are the various organs adapted to the life-needs of land-animals.

The digestive function is alike in all animals, and its evolution has ever been in one line, namely, a division of labor so as to secure more perfected results. In the mammalia this separation seems complete. From the masticating teeth to the salivary solvents, the stomach and intestinal digestions, and the intestinal absorption, every distinct portion of the process has gained its separate organ, adapted only to that one duty. The ensuing circulation is similarly specialized, being divided into the blood and the lymphatic circulations, the latter taking up normally the products of digestion and the nutritive products of the waste of the tissues ; the former applying these to the nutrition of the tissues.

A third organic requisite is that of oxidation. This has been vari-

ously performed in animals. In primitive life it acts through the outer skin. In higher forms a portion of this skin becomes adapted to that purpose, as exterior branchiæ. In the Ascidiæ it is performed by the anterior portion of the intestine. In all vertebrates it is an intestinal function, the forward portion of the intestinal tube becoming the gill of the fish. A sac-like ingrowth from the intestine—the swimming-bladder of the fish—becomes the lung of the air-breather. It eventually separates into two portions, and adapts itself more perfectly to a function which it may have partly performed in the fish.

Thus the respiratory function has gradually moved inward to a position of safety, which is only fully attained in the air-breathers. Its position in the anterior, instead of in the mid or the posterior portion of the intestine, has another reason besides that of inheritance. This is its connection with the pulmonary circulation.

In considering the division of labor in the circulation we did not speak of its separation into two distinct portions, the nutritive and the pulmonary portion. This division of function is partly attained in fishes and reptiles, fully only in birds and mammals. And the heart, which serves as a force-pump to drive the blood through the body, becomes here a double pump, one half driving the blood through the arteries, the other half driving it to the lungs, there to become aërated.

The former circulation needs to penetrate the whole body. The latter can be fully performed with little extension of its blood-vessels. And in the labor-saving principle of organs, which hinders any excess of material or of effort, the tendency is to a curtailing of the length of this pulmonary circulation. Natural selection, therefore, acts to bring the heart and the lungs into close contiguity.

But there is another reason for the position of the heart in the anterior portion of the body. Its action as a force-pump renders it an advantage that it should be placed nearest the point where it has most work to perform. Now, the brain receives a much larger percentage of the blood than any similar portion of the body. More force, then, must be exerted by the heart in the direction of the head. If it be so placed that its labor in every direction may be equalized, it should occupy an anterior position.

In quadrupeds this need becomes still stronger, for the blood going to the head has to overcome gravity, that going to the body and limbs is largely aided by gravity. This need is, of course, strongest in man, in whom the requirements of the brain are the greatest, and in whom the upward flow is directly against gravity, the downward flow directly favored by gravity.* But in all the higher animals the heart, and therefore the lungs, necessarily occupy an anterior position.

* Very probably, however, the aid which the arterial downflow of the body circulation receives from gravity is balanced by the resistance of gravity to the venous upflow. And, likewise, in the head circulation the gravitative resistance to the arterial current

Protection of the body is, to a certain extent, secured by its being inclosed in a bony case, the ribs. It may be thought strange that the advantage to be derived from this defensive armor is not extended to the whole body. It very probably would be, were there not some active influence opposing it. This influence may be, the necessity of expansion of the ventral surface. Expansion and contraction in the chest are regular and rhythmical, and are secured by the jointed connection of the ribs with the breastbone. Expansion in the abdomen is irregular and at times excessive. Incasement in an inflexible rib-case would, therefore, prove highly disadvantageous.

Yet no flexible condition can well arise in response to expansions appearing irregularly and often at long intervals. As the ribs, therefore, could not gain, by selective adaptation, the proper motive relations to these occasional expansions, and as inflexible ribs would be a disadvantage, abdominal ribs have failed to appear.

The general characteristics of the body being thus necessarily as we find them, and the position, length, joints, and action of the limbs being inevitable results of their purpose, as the organs of animal motion, it remains to trace the origin of the head with its organs.

The head is simply the carrier of the organs of the special senses. The brain, so far as its secondary action is concerned, might very well be situated in any other portion of the body, but we think it can be shown that the location of the eyes governs that of the brain, and that the head with all its organs is an adjunct of the eyes.

These important organs necessarily occupy the most elevated part of the body. The outlook is better from this location, and the safety of the animal is thus more assured. An anterior location is also highly desirable, as otherwise the forward-moving animal would be in constant peril from obstacles in its path, and would be unable to perceive the prey it was pursuing. Also, as the delicate character and exposure of the eyes tend to limit their number, the portion of the body bearing them must be sufficiently flexible to permit vision in all directions.

All these requirements tend to the production of an anterior, elevated organ mounted on a neck of flexible movement, and as long as is consistent with easy support of the weight of the head. The ears, also, are best situated upon this head organ, and in such a position as to adapt them to catch sound from all directions.

And this position of the eyes and ears necessarily requires the brain, for its fullest effectiveness, to be likewise situated in the head. For the greatest safety follows the quickest warning of danger. But, as is well known, the nerves are slow in their conveyance of sensations. The animal, therefore, whose eyes and ears are nearest the brain be-

and aid to the venous current are equal. But the fact holds good in all vertebrate animals, that the quantity of blood to be driven to the brain exceeds that to be driven to the lower body.

comes most quickly conscious of peril, and will outlive, as a rule, the one whose sensations have a longer distance to travel.

It can be easily shown that the mouth and the organs of taste and smell are as necessarily confined to the head, and that their special location is closely governed by that of the eyes.

For animals have safety of two kinds to provide for, safety from foes and safety from food; external and internal perils. Poisonous or unwholesome food is quite as necessary to be avoided as dangerous foes. The animal that is best protected against this peril has the best chance to survive. So important, indeed, is this necessity, that not alone the sight and the sense of touch and of temperature are on guard against injury from such a source, but two organs of sense, smell and taste, seem specially provided for this purpose alone.

The needful action of the eyes, as food-inspectors for the body, fixes the position of the mouth at such a distance from them that they will unavoidably perceive the food. Animals are not likely to voluntarily examine their food before eating it. They must be forced to do so involuntarily. Therefore, the eyes naturally command the entrance to the mouth, at the best distance for the most acute vision.

The relative positions of eyes and mouth being thus fixed, those of the smell and taste organs follow. Odorous emanations arise from the food significant of its character. The animal becoming most conscious of them has the best chance to escape danger. These odors naturally rise upward. The nose, as the organ of smell, is therefore best situated just above the mouth, and overhanging it, the performance of its function, as the organ of respiration, causing the respired air to sweep the lips and draw in the odors arising from the food.

The organ of taste, on the contrary, is best situated on the rear portion of the tongue, since the food must be masticated by the teeth, and partly dissolved by the saliva, ere it is in condition to excite the sense of taste. It must not be placed so far back, however, as to hinder the rejection of food warned against by the nerves of taste.

The head of the animal, then, seems necessarily to be just as we find it, the seat of the special senses and of the brain; while the relative location of these sense-organs and of the mouth, the position and elevation of the head, and the narrowness and flexibility of the neck, appear to be all necessary adaptations for the most complete protection of the whole organism.

The mammalian body, then, so far as we have yet seen, appears the best adapted of animal forms to gain extended and varied experiences of nature, to become exposed to diversified perils, and to evolve the most complete division of function. This body, once attained, is closely adhered to. While displaying thousands of minor variations, adapting it to special circumstances, it retains unvaryingly all the general characteristics mentioned. This close adherence seems to show that

its form and organic functions are the best of all adaptations attained by the animal world up to that height.

The mammalia have another advantage which we will but glance at here. The young of the mammal has a better start in life than that of any other type of animal. In this direction, also, there has been a constant development in the process of evolution, the young of lower animals being born in an embryo state, and needing to consume force in passing through various degrees of metamorphosis. The young of the mammal is fed by the mother through all the embryological stages, this being most fully performed in the highest mammals, so that their young commence an independent life at a stage to reach which the young of lower animals consume a considerable portion of their vital energy.

Yet, with all these advantages, the mammalian quadruped has not attained the highest position in animal development. It will be very easy to point out several defects in its organization, which detract from its powers as a living body. In the first place it only imperfectly overcomes gravity. Shortened as the body is, a considerable part of its weight is not supported by the limbs, and needs muscular support. This increases weight and uses up force. The head also is not directly supported by the limbs and needs powerful muscular support in the neck. The need of using the teeth as food-grasping instruments requires a forward extension of the head, instead of a vertical position over the fore-limbs.

In division of labor it is likewise defective. Thus its limbs have a double duty to perform—they are used both as organs of motion and as weapons. The herbivora use their hind-limbs for defense, the carnivora use all the limbs as offensive organs. The same may be said of the teeth. The carnivora use them both as weapons of attack and as organs of mastication. The herbivora are frequently supplied with heavy horns as defensive weapons, thus adding to the weight of the head.

Obviously, then, there are a variety of requirements to be supplied ere the most completely developed animal form can be attained. In what direction shall this further development proceed? How shall the above-named disadvantages be obviated? The first steps toward it are made when mammalian animals begin to differentiate the functions of their fore and hind limbs. We have noticed some forms of this differentiation. A more significant form displays itself in those animals which live in trees. Many of these, it is true, use all the limbs alike in climbing, and remain true quadrupeds upon the land-surface; others, as the monkeys, use the fore-limbs as grasping, the hind-limbs as supporting organs, and thus begin to separate them in function.

This separation proceeds with extreme slowness. It is only imperfectly attained in all existing monkeys and apes. For its complete attainment the differentiation must proceed to that degree that the

fore-limbs shall become useful only as grasping, the hind-limbs only as supporting organs. Necessarily, then, the pelvic joint must gradually change its direction from a right angle to a straight line. The complete result, in fact, is only attained when the hind-limbs and the body form a vertical line, the function of support being performed entirely by these limbs, while the fore-limbs are freed for other functions, and so changed as to be specially adapted for grasping.

This desideratum is attained in man, and in man only of all the animal kingdom.

In the human form, then, we find all the advantages possessed by the mammalia as a class, together with certain important features of development not possessed by any other mammalian animal. Perhaps the most important of these is the fact that in man gravitation is overcome with a less expenditure of muscular force than in any other land-animal. The whole weight of the body stands vertically above the organs of support. The muscles which in other animals act as ropes and levers of support are only called upon in man to preserve his vertical position. Evidently much less force is needed to preserve vertical equilibrium than to support horizontal weights.

The head, also, which needs muscular support in quadrupeds, in man presses directly downward upon the common center of gravity. And significantly the complete development of the brain tends to perfect this vertical position, as it yields a rounded and vertically poised head. The head in man has but one set of duties to perform, sensory and masticating labors. The hands bring food to it, instead of its having to seek food ; therefore it has no need of the horizontal position and movements found in quadrupeds. Finally, that there shall be no weight needing muscular support, the fore-limbs hang vertically downward, being sustained by bones and tendons instead of muscles.

Support on the hind-limbs releases the fore-limbs to act as the defensive and offensive organs. For their most complete adaptation to this function the position of the shoulder-joint (like that of the pelvic joint) is changed, and the arms become lateral instead of ventral limbs. Finally, the teeth are released from duty as weapons, and are confined to their proper duty as masticating organs.

Thus only in man does the organic division of labor become complete, every function having a separate organ adapted to it alone. And the stores of force are husbanded to a degree not found in any other land-animal, the weight of the body being supported by bones instead of muscles, by adjusting instead of lifting energies.

And in regard to reproduction man surpasses all other animals, except the highest apes, in division of labor and localization of function. The young of the human race thus commence life with the best possible preparation, their vital activity being husbanded so that they enter upon their individual life-work at perhaps a higher starting-point than any other animal.

In organic differentiation, then, man seems to have reached the highest possible point. Also, in avoidance of the constant forces of gravitation and friction, he has almost achieved perfection.* And he starts life with the least expenditure of force in embryological development. In all these respects he seems to have attained the utmost height of organic development.

In respect to his adaptation to the other forces of nature—his powers of sensory perception—he is also in advance of all other animals. Not only is the division of labor of the animal organs within him—the nervous, muscular, and osseous systems—complete, but his exterior sensibility to the impress of force is the most delicate of that of all animals. This is perhaps not the case in the organs of special sense, though the position of the human nose, with its nostrils directly overhanging the mouth, seems a superior adaptation to its duty in the perception of odors. But in regard to the sense of touch, not only has he a superior provision in the tactile organs of the fingers, but the naked and soft condition of the skin renders it susceptible to contact in a degree not possessed by any other animals.

Other animals, in fact, are either covered with a dense coat of hair or feathers for protection from cold, or with a thick leathery or bony skin as armor against danger. In the development of man alone has Nature pursued her most elevated path, increasing his susceptibility to exterior influence, his power of gaining sensible experience of nature, to the utmost possible degree. This is probably the true explanation of the naked condition of the human skin. His mode of life has rendered the fullest perception of nature desirable, and adaptation has consequently taken this direction, removing from his exterior surface everything opposing the utmost sensibility, and, for the same reason, hindering any undue thickening or induration of the outer skin.

Such is man—the extreme upward limit of physical progress in organic nature—the one last step forward which living beings have taken after their long permanence in the quadrupedal stage. And beyond his form no physical progress seems possible, for he fulfills what we conceive to be Nature's design, viz., to husband force by the fullest avoidance of gravity and friction, to decrease weight to the lowest available point consistent with the size and strength necessary to best adapt him to surrounding conditions, and to produce the utmost susceptibility to impression of natural force—to attain a form, in fact, having the greatest excess of available energy, and best adapted to gain experiences of the conditions of nature.

But these very advantages in the human form produce certain un-

* In the prone vertebrate, the serpent, the escape from gravitation is accompanied by a marked increase of friction. In man both gravity and friction are simultaneously decreased to the greatest possible extent. Thus the serpent and man occupy the two poles in the development of motive powers, while all other vertebrates occupy intermediate positions.

avoidable disadvantages. Man's adaptations to the conditions of nature are necessarily limited. Thus it might be supposed that a perfect animal would be adapted to traverse the water and the air, as well as the land. But such an adaptation would require extra organs, extra weight, and extra consumption of force in their support. Man, on the contrary, has become adapted to the highest field of life, and escaped an adaptation to inferior fields which would prove a disadvantage in the struggle for existence with land-animals.

His extreme sensitiveness to exterior influences gained by his naked skin is, of course, a sensitiveness to temperature as well as to touch. He is thus limited organically to tropical regions, and to some extent to a life in the shade—to a forest residence. In fact, he seems more limited in locality and in powers of resistance than most other animals. His unclad skin renders him acutely sensitive to extremes of heat and cold. He has no cortical defense against the attack of his animal foes. His limbs have become adapted to grasping and to support, but have lost their character as offensive weapons. Finally, his adaptation to an arboreal residence has become imperfect. He can not climb like a monkey, run like a deer, swim like an otter, mine like a mole, or crouch like a cat.

Physically, then, man is one of the most poorly protected of animals, seemingly a form not likely to survive in competition with his swift-running, flying, and climbing neighbors, and with his carnivorous foes, armed with tearing claws and rending teeth.

Yet in other respects he has decided advantages. One of these is a feature in which very few animals rival him, a differentiation in his adaptations to nutriment, enabling him to masticate, digest, and assimilate both vegetable and animal food. This is a decided advantage. Man is at once herbivorous and carnivorous, his field of possible food thus being doubled, and his consequent variety of adaptation to nature being likewise doubled. There is no other animal adapted to this double diet to the same degree as man. By a rather unpleasant resemblance, the hog most nearly approaches him in this respect. Yet the hog is principally a vegetable feeder, and only occasionally varies his diet to animal flesh.

A second advantage is the economy of muscular force gained by the vertical attitude. The force thus saved might have been employed in the production of an extreme agility, enabling man to escape danger by speed and alertness. It has fortunately been applied in another direction, that of the production of mental acuteness. From the time that man first employed the grasping power of his hands to seize stick or stone for defense against his foes, a process was begun which is yet far from completion. It was, in its full results, the process of mental evolution. But, for our present purpose, we must give it a more narrow significance.

In all probability man, physically, is not now what he was origi-

nally. The use of the stick or stone in defense set in motion a new process of adaptation which has tended toward a physical weakness, at least in regard to conflict with wild animals.

It was, in fact, the first step in the enhancement of animal force by the employment of the vast stores of inorganic force existing throughout nature. It was the earliest inventive action, the bringing of outer nature to human aid, which has since produced such wonderful results. Muscular vigor and acuteness of sense have probably decreased as they have been thus partly replaced. For man has gained new muscles, in his use of the forms and forces of the inorganic world, and has commenced a new process of adaptation, which has already enabled him to extend his kingdom from the tropic to the frigid zone, and which promises to make him to some extent master of the fields of water and air. And his mental experience of wider and wider conditions of nature has produced a new form of physical adaptation—that signified in clothing and habitation.

But this opens a new subject, too wide to be considered here. We can only end as we began, with the assertion that the human form occupies the apex of possible organic development, and forms the true foundation for that higher mental evolution which is still growing, branching, and flowering upward.

THE RELATIVE HARDINESS OF PLANTS.

By SAMUEL PARSONS, Jr.

THE isothermal line, curving up and down the map, is no inapt illustration of the course another line would take on the chart which sought to explain the relative hardiness of plants, only the curves of the latter would be more complex than those of the former. Who, indeed, could direct aright such a line for even individual species? and for varieties it would be wellnigh impossible. Scarcely could reliable data be furnished for the broader division of genera. And yet the investigation that does not take into account varieties misses a large number of plants possessed of the most noteworthy and valuable individual traits. The question may be easily asked, Wherein lies the difference between a variety and a species? but the answer evidently is not so easy, when we consider that every individual plant varies in a degree from all other plants; and, to render it still more difficult, we find botanists very properly ignoring the existence of varieties that may have individual characteristics invaluable to the planter.

Latitude, moreover, we find is only one factor, and a very vague one, in the problem of determining the relative hardiness of plants. Climate is the real governing element—climate, that varies with the

special conditions of every valley and hill-top. Yet the knowledge and insight that determine the relative hardiness of plants seem easy of acquisition in the eyes of the inexperienced. Still, no one, really an expert in such matters, will venture to express a decided opinion on such data as are usually obtainable. A canny Scot of our acquaintance, whose knowledge of plants in a practical way is encyclopedic—if such a term in such a connection be admissible—is a notable example of this wise cautiousness. Never was he known to positively commit himself, at least on the subject of the peculiarities of plants. "They might be hardy," he would say, "and again they might not. Circumstances alter cases." There was always a profound consideration shown for the incalculable effects of any particular environment.

That we may better realize the strangely complex character of the relative hardiness of plants, let us consider briefly the special behavior of various kinds under apparently similar conditions, and then note with care their behavior under evidently different conditions. Take Japanese plants, for instance. They illustrate how, sometimes, on two sides of the globe, in the same latitude, almost identical species and varieties appear. Whether it is the similarity of the course of the oceanic currents along their shores and the trend of the mountain-ranges inland that modify the two climates into a peculiar likeness, or still more recondite causes, the fact remains that whole genera of Japanese plants resemble in the strangest way indigenous American kinds. Retinosporas, the most popular evergreens of Japan, seem, in some cases, though confessedly distinct botanically, nearly identical in appearance with Thujas or American arbor-vitæs, and they also behave alike. In grafting, for instance, members of one genus require members of the same genus as stocks. Yet the Retinosporas, which graft well, of course, on their own stock, graft also with entire success on the American arbor-vitæ, which the botanist tells us is an entirely distinct genus. They are, likewise, equally hardy, but the variation in form and color, in both Japan and America, is much greater among Retinosporas than among American arbor-vitæs. This capacity for endurance of like conditions which appears among Japanese and Eastern American evergreens runs also through deciduous trees. There are maples on the Amoor River and in Japan which have little to distinguish them from at least one variety of maples in America, and there is a similar kinship in reference to hardiness.

These instances of resemblances in hardiness and in other features, between plants botanically widely different, might be greatly multiplied, but those mentioned will suffice to show the widespread likeness, in these respects, of many different plants throughout the globe. In face of these extraordinary instances of similarity in hardiness of plants the native haunts of which are widely removed, we have to recognize the existence of many kinds in the same region, closely related botanically, and yet entirely different in their several degrees of hardi-

ness. One of the salient instances of diversity in hardiness of nearly related plants is the behavior of Japanese persimmons in this country. It was confidently expected that they would prove hardy in America, because native persimmons were hardy, and because the general hardiness of Japanese plants in America had been often demonstrated.

But fifteen years' trial of a few detached plants, and five years' trial of thousands together of these Japanese persimmons, prove their hardiness more uncertain than that of the American persimmon. What shall we say of the other Japanese plants that fail to prove hardy in America north of Tennessee, or even Florida—of the Osmanthuses, best described as resembling the hollies in appearance, of the privets, live-oaks, Ancubas, etc.? They are common enough plants in our greenhouses, but only in very sheltered positions, and during mild winters, will any of them live uninjured in this climate. Such facts must be very perplexing to any theorist who attempts to explain why and where this or that plant is hardy.

Or let us change somewhat our problem, and consider why plants belonging to countries much nearer home than Japan, but in similar latitude, fail to prove as hardy here as many Japanese plants. Note the fact, moreover, that these trees I shall next refer to come from even colder regions than Japan, and yet Japanese plants of the same genera are usually more hardy. The ways of plants, verily, become still more puzzling when we find such evergreens as *Thuiopsis borealis* and *Thuja gigantea*, natives of northern Oregon, fail even under the best treatment sometimes, during winters of New York and Philadelphia. Some explanation may of course be attempted by adducing the peculiar climate of the Pacific coast in its rainy seasons, but then consider that many of these plants are found eight and ten thousand feet up in the mountains, and also that, when we pass a few hundred miles farther east in the same parallel of latitude, we find the same varieties and even species such as the Douglas fir becoming hardier. Few, comparatively, of the California native deciduous trees are hardy in the East, and even for many Oregon trees of the same class, such as *Acer macrophyllum*, there is much suffering in store during hard winters on the Atlantic coast. Passing over to Northern Europe, the behavior of trees is still more perplexing. To be sure, as a rule, the Gulf Stream insures milder climate in the same degree of latitude, but away up in northern Scotland, and even in Norway, we find many evergreens more hardy than in the more temperate latitude of New England. Rhododendrons, hollies, and all evergreen shrubs, if not all evergreen trees, do better there, which is doubtless to be attributed in part to a moister climate and more equable temperature, but it can hardly be that altogether. On the other hand, what can we say to the evergreen *Thuiopsis Standishii* doing better here than in England, and *Thuiopsis dolobrata* better in England than in America? Japanese maples, that seem to grow more thriftily and vigorously here than in Japan, give evidence

also of being less adapted to England than to the United States. Besides, why is it that evergreens thrive better, and are more hardy, in a cultivated state in Europe, and deciduous trees in this country? We know answers can be given by experienced observers to all these questions, that are more or less comprehensive, but we believe also that, when such answers come to be closely scanned, it will be found that they do not entirely meet the case. How is it, otherwise, that the same peculiarities in a minor degree are evident in the behavior of trees growing within a few miles of each other? One might understand why the same plants act differently farther inland, but here in the neighborhood of the coast it naturally strikes us as curious that on the Hudson River some plants are hardier than on Long Island.

There are more inexplicable facts than these. Mr. Hunnewell can grow plants on his lawn that will hardly live through some winters, even under the most favorable conditions, on any other spot about Boston.

Nor is this the strangest feature to be noticed in the behavior of plants under apparently like influences of soil and climate. Plants a few feet from each other, of the same species, will suffer in very different degrees during many winters. Rhododendrons are a notable instance of this. It is not simply that *Rhododendron ponticum* and its hybrids are not as hardy as *Rhododendron Catawbiense*, nor that the more of the Catawbiense strain there is in a Ponticum hybrid, the hardier it is, but it is that sometimes a Ponticum hybrid, usually entirely unreliable, will pass the winter unscathed, when nearly the hardiest pure Catawbiense of the plantation will be killed. But our expert says, "One did not ripen its wood as well as the other." Yes, but is it not also strange that sometimes the one which finally died was the one that had ripened its wood most thoroughly?

A few striking examples like these should be sufficient to illustrate the great difficulty that must always attend the determination of the relative hardiness of plants. Many more instances of the same character might be readily selected, but it is not necessary. We have simply endeavored to give sufficient data to warrant the general statement that the varying and complex conditions of the environment of any given plant are difficult to understand or explain on the basis of experience of another environment which, to a superficial observer, may seem to be identical with the first. Our intention is not to insist on any explanation of the facts adduced in regard to the relative hardiness of plants, but only to show distinctly the difficulties that must attend such explanations, and to point out that experience is now being purchased too dearly, and that it is, moreover, not of a sufficiently varied character. Hundreds and thousands of plants are killed every year under very similar circumstances, and it seems evident that human intelligence should be sufficient to compass some method of reducing this loss to a minimum.

The Cambridge Botanic Garden and the Arnold Arboretum, adjoining the Bussy Institute, being well organized and both managed under the auspices of Harvard College, would be perhaps the best repository of reports on the relative hardiness of plants.

The proper sources of these reports would be botanic gardens such as those of Washington and Cambridge, and parks such as those of New York and Philadelphia, the superintendents and gardeners of which might be directed to make careful investigations and fill up printed forms month by month on the behavior of plants in different localities. Above all, private individuals — and they need not be trained observers—all over the country should be encouraged to investigate in the same systematic way and report to the central repository. Consider how valuable such records of actual hardiness would be, coming from interested observers everywhere, if the resultant tables were published in a compact form! The perplexing question of the behavior of rhododendrons, for instance, would probably be explained, whereas twenty-five years of unsystematic observation has been very barren of results.

It may not be out of place in conclusion to say a word concerning the so-called acclimatization of plants. The name seems to imply the use of some peculiar treatment whereby a half-hardy plant is made hardy. There are many people who really fancy that tender plants may be rendered hardy by first protecting them carefully and then exposing them more and more by degrees until they are taught to endure a manifestly greater amount of cold than they did at first. Natural selection carried on for hundreds and thousands of years may accomplish a change of nature of this sort, but, under ordinary limitations of time, the attempt to acclimatize, in this sense, is practically futile.

WHAT IS A COLD?

By A MEDICAL MAN.

TO enjoy life, one must be in good health; and to remain free from disease is the desire of all. Yet there are some ailments which do not interfere very much with the pleasures of life, and therefore are not dreaded in consequence—nay, more, they are frequently treated with neglect, although in many instances they are the precursors of more serious disorders, which may in not a few cases have a fatal termination! How often, to the usual greetings which one friend exchanges with another, is the reply given, "Very well, thank you, except a little cold." A little cold, and yet how significant this may be! In how many cases do we find a "little cold" resemble a little seed, which may sooner or later develop into a mighty tree! A little

cold neglected may, and frequently does, prove itself to be a thing not to be trifled with. Let me, then, pray my readers to remember that small beginnings in not a few instances have big endings, and this especially where disease exists. Let us, then, consider what is a common cold.

In the first place, we must be paradoxical, and affirm that it is not a cold at all. It is rather a heat, if I may so express myself, that is, it is a form of fever, but, of course, of a very mild type when it is uncomplicated by other diseases. It is certainly in the majority of instances due to the effects of cold playing upon some portion of the body, and reacting upon the mucous membrane through the intervention of the nervous apparatus. What is called a cold, then, is in reality a fever; and, though in the majority of instances it is of such a trivial nature as to necessitate few precautions being taken during its attack, yet in some cases it runs a most acute course, and may be followed by great prostration. Even when the premonitory symptoms of a cold are developing themselves, when, for example, what a medical man calls a rigor, or, as it is popularly designated, a shivering is felt, when we would naturally suppose that the animal temperature is below par, it is at that very moment higher than the normal, thus showing the onset of fever.

Before going at once into the symptoms and nature of the disease under discussion, it will be advisable to dip a little into that most interesting department of medical science, physiology, and, indeed, without doing so, it would be quite impossible for the majority of my readers to understand the manner in which cold acts in producing the inflammatory condition of the mucous membrane of the nose, or, as it is called, the Schneiderian membrane, which inflamed condition constitutes a cold in the head. It will be necessary to understand what a mucous membrane is, what its duties are, and how these duties are performed, before entering upon a description of a disease attacking it. To take the mucous membrane of the nose as an example. We find that it is a membrane spread out over a very large area, lining as it does a great many undulations caused by the arrangement of the bones composing the walls of the nostrils, so that a very much greater surface is required to be traversed by the air entering the lungs through the nose—the natural passage—than is required by the actual length of the canal. The object of this is obvious, when we take into account the fact that the temperature of the air is usually either below or above that of the human body, and that it is almost invariably loaded with particles of matter which would irritate the lungs did they find access to them.

The tortuous passage of the nose thus tends in the first place to equalize in some measure the temperature of the atmosphere inhaled with that of the lungs; and, in the second place, the mucus which is secreted by the Schneiderian membrane, being of a tenacious nature,

tends to attract and ensnare the impurities which the air may contain. We thus see that the nostrils act as a filter to the air taken in by inhalation. If we observe any mucous surface, we can not help remarking its deep-red color, this being due to the close network of blood-vessels ramifying on its surface. In consequence of this accumulation of minute arteries and veins through which warm blood is constantly flowing, a pretty high temperature is constantly maintained in any cavity lined by mucous membrane. There is, therefore, little difficulty in understanding how important a part the nostrils play in preparing the air for its entrance into the sensitive structure of the lungs. But the nostrils do not only temper the air—they also yield to it an amount of moisture which renders it still more bland and less irritating. We see, then, that the functions of the nostrils as regards the atmosphere inhaled are threefold: 1. In equalizing its temperature; 2. In moistening; and, 3. In filtering it. The latter function is materially aided by quite a forest of minute hairs which guard the entrance to the passages.

Having noticed how distended the blood-vessels of the mucous membrane naturally are, it will not be difficult to understand how slight a disturbance of the balance of blood-supply will be necessary to produce congestion or inflammation of the structure, and such is really the case; and it is because of this that people who have what is called an irritable mucous membrane are so susceptible of cold. They have, in fact, a chronically congested mucous membrane, which, however, is usually associated with and dependent upon a disordered digestion. Yet, notwithstanding these facts, a cold is not produced by cold air acting upon the surface which suffers. It is quite true that there are individuals with peculiar idiosyncrasies who take catarrh when they smell certain substances. For instance, many can not go into a room where powdered ipecac is exposed without immediately catching catarrh in the nasal passages; and there is reported the case of a man who could not smell a rose without being affected in a similar way.

We must now go a step further before we can understand the *modus operandi* by which a cold in the head, or any other region, is produced. It has been shown that one of the functions of a mucous membrane is to secrete mucus. But what is it that makes the secretion vary in quantity? Well, an irritant applied directly to the surface may produce an excessive flow, and this superabundance of mucus is thrown out by an effort of nature in its endeavor to shield the delicate membrane and remove the irritant; this may happen also when there is an excessive amount of blood in the vessels, which is the case when congestion exists, the distention of the blood-vessels acting as an irritant, and supplying in greater amount the fluid from which the mucus is extracted, thus tending to excite the secreting power to greater effort. Thus we have an explanation of the excessive discharge in catarrh of the nose. But, when the direct irritant is removed, the

unnaturally abundant discharge ceases. Not so, however, when the superabundance is due to the effects of cold; for, in the latter case, a diseased condition is set up, which will only disappear when the effects of the exposure upon the nervous system have passed away.

Having demonstrated that cold is not produced by the action of cold air playing upon the part affected, but that, on the contrary, it is an effect of cold acting upon a distant part of the body, it will be necessary to explain how this is brought about. If a person sits in a draught of cold air, and this draught is directed upon the back of his head, the chances are that a catarrh of the nasal passages will result, and this is produced by what is called reflex action of the nerves. Here it will be necessary to diverge a little, and explain what reflex action is. It must be understood, then, that there are numerous nervous centers connected with the spinal cord. These nervous centers send filaments of their nerves to various portions of the body. For example, a nerve-center may be placed alongside the spine in the neck, and from this point nerves may be distributed to the back of the head and the mucous membrane of the nose. One important function of these little bodies is to control the supply of blood to different surfaces and tissues and organs. This is done by a system of minute nerves which are distributed on the arteries, by which the vessels are kept in a state of contraction. Now, if these nerves are severed from the main trunk, the blood-vessels immediately expand to the full extent of their caliber, and congestion is the result; or, if these nerves are paralyzed, the same effect is produced. Sometimes a very slight shock produces a temporary paralysis of these minute nerves when a rush of blood takes place into the arteries, of which blushing is a good example; but the nerves soon recover their control over the blood-supply, and the blush passes away. Then, again, the shock may produce quite the opposite effect: this may be so severe as to cause such extreme contraction of the blood-vessels that a deadly pallor pervades the face, as, for instance, in severe shock from fear. This, however, is caused more by the effect of shock acting upon the nerve-centers which supply the heart with motor power.

But let us suppose that one extremity of a nerve arising from a particular nerve-center is irritated; this is communicated to that center, which is affected thereby, it may be slightly or more severely. The irritation may be so great as to prostrate for the time being the nerve-center, and, in consequence, all the nerves arising from it are thrown into a state of inaction. This is called the reflex action of that nerve-center, because the effects of the irritant applied to one part of the body are thereby reflected to other parts. Instances of reflex action may be seen frequently in every-day life. Take, for example, the action of the eyelid when an object threatens to enter the eye. The retina perceives the object advancing; this is telegraphed to the nervous center supplying the muscles which open and shut the eyelids,

and immediately a message is sent back to the eyelids to shut, and exclude the particle of matter that threatens to enter the eye. All this is done so quickly that it is hardly possible to realize that there is time for reflex nervous action being brought into play.

Another instance of reflex action, but this time influencing the secretions, may be citéd. Who is not familiar with the effect of a savory smell, or the sight of some luxury, upon the salivary secretion, so that, to use a common expression, "the mouth waters"? In the first, the olfactory nerve is the means by which the impression is conveyed to the nerve-center; in the other it is the optic nerve which is the transmitting agent; but in each case the impression is reflected to that nerve controlling the salivary secretion, with the effect of producing an increased flow of saliva. We thus see that the secretions can be influenced by one nerve conveying its impression to another whose filaments take origin in a common center.

Now, to come to the subject more directly under consideration in this paper, we must comprehend how cold acting on one part of the body produces catarrh of the nasal mucous membrane. Exposure to the most intense cold for a lengthened period will not produce this effect. Indeed, we find it invariably the case that severe frost in winter is, so far as catarrh is concerned, the healthiest weather we can have. During the prevalence of frost, as a rule, colds are at a minimum. The system here shows its power of accommodating itself to the circumstances surrounding it, and actually benefits by the prevailing low temperature. Let us, however, suppose a person to be sitting in a room the temperature of which is, say, 70° Fahrenheit, and that a current of cold air is rushing in at an open door or window, and playing upon the back of his head, or it may be on his legs or feet, and the probability is that he will "catch cold," and in nine cases out of ten this cold will be a catarrh in the head, and, what may appear more remarkable still, only one nostril will at first be affected. Now, if the catarrh was due to the inhalation of cold air, both nostrils would suffer; but it is not so; for, as each side of the body is supplied by its distinct set of nerves, so only that side is affected through which the reflex disturbance has been transmitted. The *modus operandi* is the following: The draught of cold air, acting, we will suppose, on the back of the head, conveys through the sympathetic nerve, which ramifies on the scalp, a shock to the nervous center from which these nerve-fibers proceed; but we must understand that this nerve-center sends its filaments to other portions of the body, and so the shock which this center receives by one set of nerves is reflected by another set to some surface quite remote from that primarily acted upon, and in this way a temporary paralysis of the nerves supplying the blood-vessels of the mucous membrane of the nose is brought about. In consequence, these vessels become dilated and engorged, and the shock which has brought about this congestion continuing, disturbs the

equilibrium of the blood-supply, and so an inflammatory condition is set up. When this exists the blood-vessels are enormously distended; consequently, an excess of blood passes through the part, the little cells which secrete the mucus being thus excited and working much more rapidly than when in health. In this way the enormous discharge of mucus, which accompanies a cold in the head, is accounted for.

Another effect of this irritation of the mucous membrane is sneezing, which is an effort of Nature to restore the equilibrium of the nervous center by another kind of reflex action. Sneezing in catarrh is a method Nature adopts to stimulate the prostrate nervous center, and thus enable it to reassert its proper control over the blood-supply to the part; indeed, it will be found that the effects of being exposed to a draught of cold air are often completely destroyed by a succession of sneezes. Of course, Nature does not always immediately succeed in these efforts; but, when she does not, the shock from which the nervous center suffers gradually passes away, and the blood-vessels again come under the control of the little nerves which regulate their caliber, and so the catarrh disappears in a few hours, or at most in a few days. It sometimes happens that the shock from the cold air acting upon the nervous center is of such severity that the consequent inflammation is intense enough to check the secretion of mucus altogether, and in consequence the mucous membrane is dry as well as inflamed, and the suffering very much intensified.

So far, we have only glanced at a cold in the head which passes away in a few hours, but this is not always the happy termination. There is a peculiar tendency which inflammation possesses of not leaving off where it commenced, but of invading the tissues in its immediate neighborhood, and more especially when the tissue is continuous with that primarily attacked, as is the case with the mucous membrane of the air-passages. A cold may commence in the head, and rapidly spread by what is technically termed continuity of tissue into the chest; and so what at the first promised to be only cold in the head may terminate in an attack of bronchitis, or even inflammation of the lungs.—*Chambers's Journal.*

THE PURIFICATION OF SEWER-WATERS.*

By M. E. AUBREY-VITET.

THE sewers of Paris discharge 262,646 cubic metres of liquid matter every twenty-four hours. It is estimated that the quantity discharged will be increased before many years to 300,000 cubic metres daily. Each cubic metre of liquid contains two and a half

* Translated and abridged from the "Revue des Deux Mondes."

kilogrammes of solid matter, of which one kilogramme and a half is merely in suspension. This stuff, flowing into the Seine, causes an accumulation of 116,000 cubic metres of mud in a year at the mouths of the conduits, and makes necessary for its removal an annual expenditure of nearly 200,000 francs. Even this sum is not adequate for the purpose. Far from securing the removal of the obstruction, it is not even sufficient to prevent a continued accumulation, and the muddy deposits are constantly extending farther down the river, and at the same time becoming thicker. Since 1875 they have become about a yard thick, and occupy nearly a quarter of the bed of the river from Asnières to beyond Chatou. The Seine has, moreover, been made foul, and its waters have become unfit for domestic use, poisonous to fishes, and a source of fetid emanations.

The authorities of Paris have been for many years considering measures to remove these sources of impurity from the river. As they are rich in fertilizing matters, the thought was suggested that they might be turned to good account for purposes of agriculture. It was therefore resolved to apply them to works of irrigation in the peninsula of Gennevilliers, where, passing through the thin soil of red earth underlaid with gravel, they might leave their rich manures on the arid land, and be returned to the Seine purified. Five hectares (twelve and a half acres) of land were chosen to be irrigated by the sewer-water, which was conducted in trenches around garden-beds. These lands in return produced abundant crops of the coarser vegetables. Three years afterward, in 1869, independent gardeners began to take in the sewer-water, and the demand for it increased, so that, in 1876, 115 hectares were irrigated, and in 1880 more than 300 hectares. Had the use of the sewage-water as a fertilizing material been the only condition to be fulfilled, the success might have been pronounced complete. The principal object, however, was the purification of the Seine, and in this only the most insignificant result was obtained; for the gardens were capable of taking only a minute fraction of the sewage that had to be disposed of. Complaints of bad effects upon health were increased rather than diminished, so that, in 1875, the Minister of Public Works appointed a commission to devise some means of remedying the unpleasant situation.

A plan was submitted by eminent engineers, under which it was believed the Seine could be definitely relieved of the noxious substances which were defiling it. This plan contemplated the convection, by means of new machinery and conduits which were to be constructed for the purpose, of the foul waters to the peninsula of St. Germain, where it was thought 6,300 hectares of land might be applied to the reception and disposition of them. Of this tract, 1,500 hectares of denuded and sterile land in the forest of St. Germain might be employed as a place of deposit, where the sewage that was not used in irrigation could be turned on and absorbed into the ground, for it was

foreseen that the use of the water would not be uniform, and that in certain weathers and seasons the cultivators would be as anxious to keep it off from their lands as they would be at other times to draw it on. This proposition brought out a general protest. The region which it was proposed to irrigate was largely occupied with country-seats whose proprietors did not at all relish the introduction of the objectionable matter so near their homes. Additional force was given to their objections by reports that Gennevilliers had become subject to infiltration of the waters, and afflicted with fevers generated by them. The project was withdrawn for a time, but was eventually renewed, with the feature of irrigation omitted. In its modified form, it contemplated only the employment of the 1,500 hectares of the forest of St. Germain as a reservoir, on which the sewage-matter should be turned to be absorbed in the ground. This proposition aroused a more determined resistance than the others. Those who lived along the line of the proposed conduit apprehended that the foul waters might at some time be turned upon their own land; the residents of the neighborhood of the forest regarded with dismay the establishment at their doors of a vast cesspool in the shape of a tract of land which should be covered daily with nearly 200 cubic metres of water, with 60,000 or 70,000 cubic metres of nastiness in a year. The plan is, moreover, defective, for it is not capable of satisfying either of the conditions which are had in view.

The conditions which are essential to a complete solution of the problem must provide for the purification of the sewage and the preservation of the river from contamination with it, and for the utilization of the rich manures which are contained in the waters. The former condition, in fact, is imposed as an absolute necessity; while the abandonment of the second would only constitute a certain economical loss. Irrigation is really contemplated only as one of the means to the end; but it is a very inadequate means, for its successful adaptation to the chief purpose would require the employment of a larger quantity of land than it is practicable to obtain for the disposal of the sewage of a large city. A city of ten or twenty thousand inhabitants might with comparatively little trouble find the three hundred or five hundred acres in its vicinity which would be requisite for this purpose; but, with a city twice as large, the problem is more complicated, while, in a metropolis, it becomes impossible of solution.

Sewage-water, when used for irrigation, is undoubtedly rendered innocuous. It might seem at first sight feasible to combine the two operations, so as to accomplish both objects at once. There is, however, an essential difference in the conditions required for the two solutions which makes the combination impracticable. Ten or twenty times as much land would be required to utilize the waters by irrigation as would be needed simply to absorb the foul matter and cause it to be destroyed by slow oxidation. Thus, the 1,500 hectares of the

forest of St. Germain would be as efficacious, if their action merely as an absorbing medium is contemplated, as 40,000 or 60,000 hectares would be in a scheme for irrigation. The demand for the water under the operations of irrigation would necessarily be very fluctuating. None would be wanted in the winter or in hot weather. While green crops might require much during the whole season of their growth, grain-crops must be carefully protected against it as the season of their ripening approaches. What is to be done with the constantly accumulating supplies of waste water during these seasons when it can not be used?

The whole difficulty arises from the fact that the fertilizing matter which we wish to make useful is drowned in an excess of water. It is this excess which renders sewage unfit for the fertilization of cereals, crops which are too often injured by the superabundance of rain-water. And it is the same excess which makes it impossible to find sufficient surfaces on which it can all be employed in the cultivation of kitchen-garden vegetables, with whose demands its organic constituents well agree. Were this matter extracted in a dry state, it would furnish a precious element of fertilization to a large agricultural interest; and we might preserve it without difficulty and without loss, and transport it at will to apply it to crops of all kinds. At the same time, the water in which it is held could be returned clear and wholesome to the rivers, whose salubrity it is now destroying. Clearly, there can be no discrepancy in the conditions required for the accomplishment of this double object; whatever favors one side must be equally favorable to the other. The two results are absolutely concordant, and may be produced at the same time by one and the same operation, an operation which we may call decantation. The practicability of this process is established by the fact that it has been adopted and is employed with complete success in a large factory in the neighborhood of Paris.

The paper-mill of Essonnes has to deal with 10,000 cubic metres of foul water a day. For two years it has returned to the river Essonnes these 10,000 cubic metres of water clarified, while it has at the same time extracted the mud which they held, and delivered it in a solid state as manure to the agriculturists of the neighborhood.

The apparatus employed at this establishment is composed of two parts, corresponding with two very distinct phases of the operations:

First, is a series of water-tight basins, or tanks, which are used in the decantation, properly so called, of the foul waters.

Second, is arranged a series of tanks having permeable bottoms, constructed parallel with the former tanks, but on a lower level; these are destined for the drainage of the mud which is deposited in the decanting-vats.

The process is as follows: The foul waters from the factory are drawn into a single conduit from about twenty inches to two feet wide, along and over which is disposed a series of circular bucking-

tubs, containing lime-water, a substance which is known to be very efficient in securing the precipitation of organic matters. The tubs are provided with dashers, which keep the lime-water constantly in suspension, and with gauged faucets, which permit it to be introduced regularly in the proportion of two hundred to two hundred and fifty grammes of lime to the cubic metre of water into the current of foul water which is flowing at the foot of the tubs. A few eddies produced by means of artificial obstacles placed in the conduit secure immediately a complete mixture of the lime with the foul water. As soon as the lime-water is introduced, the waste waters almost wholly lose their offensive odor, and cease to offer the slightest danger from noxious exhalations.

The water having been thus prepared in its passage through the conduit, is distributed into ten basins of decantation, each about sixty-five feet long, twenty feet wide, and five and a half feet deep, which are arranged side by side. Each of the basins has a capacity for the decantation of a thousand cubic metres of liquid a day. The water is constantly entering at one end in each, and flowing out over the top at the other end. The rate of flow is almost imperceptible, being hardly a millimetre a second, and precipitation takes place as completely as if the water were quite still; consequently, the water goes out fully clarified. Thus a course of about sixty-five feet in length, which, at the rate of ·001 of a metre a second, represents a delay of nearly six hours in the basin, suffices to clear the water of all matters in suspension. A talus of mud is gradually formed in the bottom of the tank, which at the end of a week becomes flush with the surface of the water at the entrance-end, and just covers the bottom at the end of the outlet. The basin has now produced all the effect of which it is capable. If any more water is allowed to go through it, it will contain mud in suspension, for it is still in the act of precipitating it when it goes out. The operation must be stopped here. We close the feeding-gate of the tank, draw off the clear water that is left in it by means of a decanting-tube, and lay bare the talus of mud.

The bottom of the basin is slightly inclined in a contrary direction to the course of the water, and is provided with a large valve at the lower end. On opening this valve, the mud, which is still in a very liquid condition, is passed into a lower basin—the drainage-basin—of the same capacity as the former one, and so disposed that its upper surface is a little below the bottom of the same. The first tank may be put in operation again immediately after the mud has been drawn from it.

The side-walls of the drainage-basin are of tight masonry, but the bottom is made as permeable as possible. For this purpose a floor of scoria is prepared and provided with a series of pipes which lead the water out into a collector. The arrangement is admirably adapted to the purpose for which it is designed, and quite obviates the diffi-

culty of drying the mud fast enough to enable it to be taken away at a profit, which has prevented the success of all previous efforts at purification by deposition. The mud which is spread on the permeable bottom does not soil the scoria, but leaves it perfectly clean, while the water flows clear from the end of the drains. After two or three days, according to the weather, the mud will appear cracked at some points, and finally over the whole surface. After a week it will have acquired consistency enough to be cut with a shovel. A cart is then brought into the basin, and after a few hours it is emptied and is ready to receive a new charge of mud. The scoria not having been soiled, requires no cleaning, and will be as ready for use even after the end of ten operations as at the beginning.

The drained mud is carried in the shape of large lumps to an open yard, where it is dried in the air without giving forth any odor. It contains about seventy-five per cent. in weight of water at the time it leaves the basin, but the amount of water is reduced after two or three months of exposure to not more than fifteen or twenty per cent.

These operations are of the simplest character, and involve nothing cumbrous. The whole system, with its decanting and drainage tanks, its open yard and the necessary roads, occupies a surface of not more than two hectares, or five acres, for the effective purification of 10,000 cubic metres of water every twenty-four hours. Paris has to get rid of thirty times as much foul water as the Essonnes paper-mill, or 300,000 instead of 10,000 cubic metres a day. The system practiced at Essonnes would, therefore, have to be applied on a scale thirty times as large to be adapted to the needs of Paris. Can it be made to succeed on such a scale? What is there to prevent it?

No difficulty is offered by the composition of the sewer-waters. We have procured a quantity of water from the great collector of Asnières, and have subjected it to the same treatment that is given the waste water at Essonnes. On adding to it lime-water in the proportion of 250 grammes of lime—yes, even in the smaller proportions of 200 and 175 grammes—to a cubic metre of water, a complete precipitation was promptly produced. At the end of four or five hours the water became clear and limpid.

The extent of land required to conduct the operations of decantation, drainage, and drying, on the scale demanded by the city of Paris, seems formidable at the first sight, but it is not really so. As we have seen, the whole system at Essonnes occupies only two hectares, or five acres, of land. For the city of Paris thirty times as much land, sixty hectares, only 150 acres, would be needed to give room for all the apparatus and all the manipulations; that would be a small tract compared with the 1,500 hectares, or 3,750 acres, on which it is proposed to establish a nuisance in the forest of St. Germain.

The scheme will compare favorably with any other that has been proposed, in the cost of constructing and operating the works. The

tanks, occupying six hectares, or fifteen acres, would have to be built up with walls of solid masonry, at an expense of about 1,200,000 francs. A similar sum may be added for the installation of the roads, ways, carts, and other accessories, making a total of about 2,500,000 francs, or $500,000—a mere drop in the budget of the city of Paris. The expense of labor at Essonnes is twenty francs a day; at thirty times as much, it would be 600 francs, or $120, a day at Paris. Add to this the expense of carrying away the manure, in case no return is derived from sales, and the price of the daily supply of lime, estimated at the highest probable figures, and the whole daily expense of operation at Paris rises to 3,000 francs, or $600. The year's aggregate of these daily expenses, with the interest on the cost of original establishment (which we now place, to cover all possible additions, at double the amount of the estimate we have just made), gives the total cost of the application of the Essonnes system to the purification of the sewer waters of Paris at 1,345,000 francs, or about $260,000, a year. The cost of managing the proposed works for the absorption of the sewage in the forest of St. Germain is estimated at 2,120,000 francs, or about $403,000, a year, showing a difference of more than $140,000 a year in favor of the plan of desiccation as pursued at Essonnes.

The difference in favor of this plan is much greater than appears from these figures, for no account has been taken of the probable economic value of the desiccated mud as manure. By actual analysis this mud has been found to contain from eleven to fifteen grammes of nitrogenous substances, and from twenty to twenty-five grammes of phosphate of lime, per cubic metre. The whole deposit from a year's sewage of Paris would contain nitrogenous matters enough to suffice for the fertilization of 75,000 acres of land. It is certain that a sale would be gradually found for this valuable matter, the proceeds of which, estimated eventually to amount possibly to 1,500,000 francs a year, would in the end more than defray the entire cost of maintaining the system of extraction.

MR. FRANK BUCKLAND.

By SPENCER WALPOLE.

EVENTS, in the present time, follow one another with such rapidity, and the favorites of society pass in such constant succession over the stage, that the most startling occurrences are only regarded as nine days' wonders; and men who have even filled a prominent place are almost forgotten before a monument is erected to their memory. Under such circumstances it may prove an almost hopeless task to recall attention to the character of a man who held only a com-

paratively subordinate official position, and who has left no first-rate work behind him to illustrate the achievements of a singularly ready pen. Yet Mr. Frank Buckland occupied so exceptional a position, and held it so long, that common justice requires that his memory should be preserved; and a short article on his doings, on his character, and even on the eccentricities which formed part of his character, may be welcome to hundreds of persons who knew and loved the man, and to thousands of other persons who did not know the man but loved his writings.

Francis Trevelyan Buckland was the eldest son of the Very Reverend William Buckland, the founder of the modern school of geology, the author of one of the best known of the Bridgewater Treatises, and Dean of Westminster. His mother—Miss Morland before her marriage—threw herself into the geological researches which made her husband famous, and frequently proved a ready assistant to the Dean. His father was probably one of the most popular lecturers ever known at Oxford. With the zeal of an enthusiast, he never confined his teachings to the lecture-room, but frequently organized parties to scour the neighborhood of the university, and explained the geology of the district standing on the very stones on which he was commenting. He had the rare art of throwing interest into the most abstruse subjects; and stories are still told of him, to illustrate his ready wit, which would enliven any article. In 1826, when his eldest son was born, he had already acquired a considerable reputation; and he chose as sponsors for his boy two men who both filled some position in the world—Sir Francis Chantrey, the sculptor, and Sir Walter Trevelyan, the apostle of temperance. The boy owed his two names, Francis Trevelyan, to his two godfathers. But these names are probably unfamiliar to the majority of the people who were afterward acquainted with him; the future naturalist almost always signed himself, and friends and strangers always spoke of him as, Frank Buckland.

Dr. Buckland is said to have expected his son's birth with as much impatience as Mr. Shandy awaited the arrival of Tristram. When the nurse told him that the child was a boy, he declared that he should go at once and plant a birch, for he was determined that his son should be well brought up. The declaration proved a prophecy. Young Buckland was educated by his uncle, Dr. Buckland, of Laleham, the friend and kinsman of Dr. Arnold, but a most severe and even brutal pedagogue. He was subsequently sent to Winchester, and in due course passed on to Christchurch. At school he certainly received his share of chastisement, and within a year or two of his death he showed some of his friends scars on his hand which he said were his uncle's doing. He was probably a trying pupil to an impatient schoolmaster; yet he contrived to acquire a large share of classical knowledge. He had whole passages of Virgil at his fingers' ends. He used to say, when he could not understand an act of Parliament,

that he always turned it into Latin; and within a fortnight of his death he was discussing a passage of a Greek play with one of the accomplished medical men who attended him, interesting himself about the different pronunciation of ancient and modern Greek and the merits of Greek accentuation. Mathematics were not supposed to form a necessary part of a boy's education forty years ago, and it may be doubted whether even his dread of his uncle's ferule or the discipline at Winchester could have induced him to make any progress in the study. To the end of his life he always regarded it as a providential circumstance that nature had given him eight fingers and two thumbs, as the arrangement had enabled him to count as far as ten. When he was engaged on long inspections, which involved the expenditure of a good deal of money, he always carried it in small paper parcels, each containing ten sovereigns; and, though he was fond of quoting the figures which his secretary prepared for him in his reports, those who knew him best doubted whether they expressed any clear meaning to him. He liked, for instance, to state the number of eggs which various kinds of fish produced, but he never rounded off the calculations which his secretary made to enable him to do so. The unit at the end of the sum was, in his eyes, of equal importance to the figure, which represented millions, at the beginning of it.

Of Mr. Buckland's Christchurch days many good stories are told. Almost every one has heard of the bear which he kept at his rooms, of its misdemeanors, and of its rustication. Less familiar, perhaps, is the story of his first journey by the Great Western. The dons, alarmed at the possible consequences of a railway to London, would not allow Brunel to bring the line nearer than Didcot. Dean Buckland in vain protested against the folly of this decision, and the line was kept out of harm's way at Didcot. But, the very day on which it was opened, Mr. Frank Buckland, with one or two other undergraduates, drove over to Didcot, traveled up to London, and returned in time to fulfill all the regulations of the university. The Dean, who was probably not altogether displeased at the joke, told the story to his friends who had prided themselves on keeping the line from Oxford. "Here," he said, "you have deprived us of the advantages of a railway, and my son has been up to London."

It was probably no easy task to select a profession for a young man who had already distinguished himself by an eccentric love for animals, which had induced him to keep a bear at Oxford and a vulture at the deanery at Westminster. At his father's wish, Mr. Buckland decided on entering the medical profession. To qualify himself for his duties, he studied in Germany, at Paris, and at St. George's Hospital. While he was at Paris the cholera was raging, and the patients who died of it in hospital were allotted to the Anatomical School. Mr. Buckland, however, had the stoutest of nerves and the strongest of constitutions, and never contracted any illness during the year of

sickness. He returned to London, and soon afterward became house-surgeon at St. George's. He used to say that the cases which were brought into the accident ward grouped themselves into classes according to the hours of the day. The suicides came at an early hour of the morning; the scaffold accidents next, since a scaffold, if it gave way at all, gave way early in the day; the street accidents afterward, and so on. At St. George's he collected a fund of good stories, with which he used to amuse his friends to the last days of his life. One of the best of them told, as he never minded his stories telling, against himself. An old woman came to the hospital with a cough, which she declared nothing would alleviate except some sweet, luscious mixture which another out-patient, a friend of hers, had received. The old woman was given a bottleful of the mixture, and returned again and again for more, though her cough got little better. At last Mr. Buckland's suspicions were aroused, and he desired that his patient should be watched. She was watched, and was found outside Chelsea Hospital selling the mixture in halfpenny tarts.

In 1854, while he was still engaged at St. George's, he was offered and accepted the post of assistant-surgeon in the Second Life Guards. Perhaps no army surgeon ever enjoyed so much popularity among his brother-officers. The friends whom he made during his nine years with the regiment remained his friends to the day of his death; and, whenever any of them happened to meet him, Mr. Buckland had an endless store of anecdotes of his old Life Guards days. The nine years during which he served with the regiment were probably the happiest of his life. He left it on the surgeoncy falling vacant, and on finding that the rules of the service necessitated his own supercession by the transfer from another regiment of another surgeon. But during the nine years through which he had served his name had become famous. His contributions to the "Field" newspaper and his "Curiosities of Natural History" had made natural history popular in thousands of households; and the exertions which he had already commenced in the cause of fish-culture had marked him as a man with an idea. Thus he left the army a known man, and during the next few years relied on his pen. Unfortunately, he was unable to continue contributing to the paper which he had been instrumental in originating. Differences arose between himself and the conductors of the "Field," and Mr. Buckland, separating himself from his fellow-laborers, founded "Land and Water." It is not too much to say that the latter periodical was indebted to his pen for its existence and reputation.

A new sphere was, in the mean while, preparing for Mr. Buckland's energies. In 1861 Parliament had sanctioned the appointment of two Inspectors of Fisheries for England and Wales. One of these gentlemen, Mr. Eden, retired in broken health in 1867, and Mr. Buckland was chosen as his successor. He had hardly been appointed when his colleague, Mr. Ffennell, died, and another gentleman had to be chosen

for the second inspectorship. The old traditions of the office were thus snapped at the period of Mr. Buckland's appointment, and the new inspectors, without the assistance of an experienced colleague, had to map out their own policy. This is not the place to describe the policy which they pursued, or the results which ensued from it. It is sufficient to say that no public officer ever threw himself so heartily into his work as Mr. Buckland. His zeal frequently led him into imprudences which would have told severely on a less robust constitution, and which, perhaps, had the effect of shortening his own life. He has been known to wade up to his neck in water, and change his clothes driving away from the river on the box of a fly. This was an exceptional case; but it was a common thing for him to sit for hours in wet boots. He rarely wore a great-coat; he never owned a railway-rug; he took a delight in cold, and frequently compared himself to a polar bear, which languished in the heat and revived in the frost. The pleasure which Mr. Buckland derived from cold accounted for many of his eccentricities. Even in winter he wore the smallest amount of clothing; in summer he discarded almost all clothing. The illustrated papers, which have published portraits of him at home, have given their readers a very inaccurate idea of his appearance at his house in Albany Street. Those were very rare occasions on which he wore a coat at home. His usual dress was a pair of trousers and a flannel shirt; he deferred putting on socks and boots till he was starting for his office. Even on inspections he generally appeared at breakfast in the same attire, and on one occasion he left a large country-house, in which he was staying, with no other garments on. While he was driving in a dog-cart to the station he put on his boots, and as the train was drawing up to the station, at which a deputation of country gentlemen was awaiting him, he said with a sigh that he must begin to dress. Boots were in fact his special aversion. He lost no opportunity of kicking them off his feet. On one occasion, traveling alone in a railway-carriage, he fell asleep with his feet resting on the window-sill. As usual, he kicked off his boots, and they fell outside the carriage on the line. When he reached his destination the boots could not, of course, be found, and he had to go without them to his hotel. The next morning a plate-layer, examining the permanent way, came upon the boots, and reported to the traffic-manager that he had found a pair of gentleman's boots, but that he could not find the gentleman. Some one connected with the railway recollected that Mr. Buckland had been seen in the neighborhood, and, knowing his eccentricities, inferred that the boots must belong to him. They were accordingly sent to the Home Office, and were at once claimed.

We have said that he rarely wore a great-coat, and when he did so it was apparently more for the value of the additional pockets it contained than for its warmth. One of his good stories turned on this. He had been in France, and was returning, *via* Southampton, with an

overcoat stuffed with natural-history specimens of all sorts, dead and alive. Among them was a monkey, which was domiciled in a large inside breast-pocket. As Buckland was taking his ticket, Jocko thrust up his head and attracted the attention of the booking-clerk, who immediately (and very properly) said, "You must take a ticket for that dog, if it's going with you." "Dog?" said Buckland; "it's no dog; it's a monkey." "It is a dog," replied the clerk. "It's a monkey," retorted Buckland, and proceeded to show the whole animal, but without convincing the clerk, who insisted on five shillings for the dog-ticket to London. Nettled at this, Buckland plunged his hand into another pocket and produced a tortoise, and, laying it on the sill of the ticket-window, said, "Perhaps you'll call that a dog, too." The clerk inspected the tortoise. "No," said he, "we make no charge for them—they're insects."

If a close observer were asked to mention the chief quality which Mr. Buckland developed as Inspector of Fisheries, he would probably reply, a capacity for managing men. He had the happiest way of conciliating opposition, and of carrying an even hostile audience with him. It frequently occurred that the fishermen, at the many inquiries which his colleague and he held, looked in the first instance with suspicion on the inspectors. They never looked with suspicion on them when they went away. The ice of reserve was thawed by the warmth of Mr. Buckland's genial manner; and the men who, for the first half-hour, shrank from imparting information, in the next three hours vied with one another in contributing it. Mr. Buckland was equally at ease with more educated audiences, though in their case he was perhaps less uniformly successful. If he had been a politician, he would have been a greater mob orator than Parliamentary debater. But the higher classes, like the lower classes, could not resist the warmth of his manner or the ring of his laughter. He could not, in the most serious conversation, refrain from his joke; and some persons will recollect how on one occasion he was descanting, at a formal meeting, on the advantages which would ensue from the formation of a fishery district: "You will be appointed a conservator, and then you will impose license duties, and the money—probably three hundred pounds—will be paid to you." "And what shall I do then?" "Why, then," replied Mr. Buckland, "you had better bolt with it."

His love of a joke distinguished him as a lecturer. He remembered his father's lectures, and always thought it his first duty to make his audience laugh; and he had a dozen stories ready to provoke laughter. The excuse of a milk-boy, on a fish being found in the milk—"Please, sir, mother forgot to strain the water"—was one of those which did frequent duty. The same love of a joke followed him on his official inquiries. He left on one occasion a parcel of stinking fish, which he had carried about with him, and forgotten, neatly done up in paper, in a fashionable thoroughfare in Scotland, and stood at the hotel-window

to watch the face of the first person who examined it. He amused himself, one Sunday evening, on another occasion, in making herring-roe out of tapioca-pudding and whisky, to puzzle the witnesses whom he was to examine on the Monday; and he raised a laugh on a third occasion by telling a witness, who said he was a shoemaker, that, to judge from the appearance of the children's feet, he should think he had a very poor trade. Throughout his journeys, specimens of every kind, living, dying, and dead, were thrown into his bag, possibly to keep company with his boots or his clothes. The odor of the bag usually increased with the length of the inspection, and on one occasion, when it was exceptionally offensive, he said to the boots of a very smart hotel, "I think you had better put this bag into the cellar, as I should not be at all surprised if it smelt by to-morrow morning."

The love of fun and laughter, which was perceptible while he was transacting the dullest business, distinguished him equally as a writer. It was his object, so he himself thought, to make natural history practical; but it was his real mission to make natural history and fish-culture popular. He popularized everything that he touched; he hated the scientific terms which other naturalists employed, and invariably used the simplest language for describing his meaning. His writings were unequal: some of them are not marked by any exceptional qualities. But others of them, such as the best parts of the "Curiosities of Natural History," and "The Royal Academy without a Catalogue," are admirable examples of good English, keen critical observation, and rich humor. His best things, he used to say himself, were written on the box of an omnibus or in a railway-carriage. "The Royal Academy without a Catalogue" was written between London and Crewe, and posted at the latter station. He had originally acquired the art of writing in a railway-train from the late Bishop of Oxford. He practiced it with as much zeal as the Bishop did, and with as good effect. The more labored compositions which Mr. Buckland undertook did not always contain equal traits of happy humor. He was at his best when he took the least pains, and a collection of his very best pieces would deserve a permanent place in any collection of English essays.

Desultory work of this character made Mr. Buckland's name a household word throughout the country. His articles were copied and recopied into various newspapers, and obtained, in this way, hundreds of thousands of readers. But, at the same time, this desultory work necessarily prevented him from accomplishing any literary task of first-rate excellence. Some of his personal popularity was thus purchased at the cost of his future reputation; and a mass of knowledge has died with him which might otherwise have been preserved. It is no exaggeration to say that he had collected during his busy life a vast store of information. He had trained himself to observe, and his

eye rarely missed anything. He thought that he had facts at his disposal which would have enabled him to answer the great doctrines which Mr. Darwin has unfolded. Evolution was eminently distasteful to him; only two days before his death, in revising the preface of his latest work, he deliberately expressed his disbelief in it, and he used to dispose of any controversy on the subject by saying: "My father was Dean of Westminster. I was brought up in the principles of Church and state; and I will never admit it—I will never admit it."

Though, however, on such occasions as these Mr. Buckland used the language of advanced Tories, he habitually shrank from political discussion. He declared that he did not understand politics, and that he reserved himself for his own immediate pursuits. Into these pursuits he threw himself with his whole energy; and his energy was extraordinary. The greatest example of it was in the search which he made for John Hunter's coffin in the vaults of St. Martin's church. He literally turned over every coffin in the church before he found the one of which he was in search, spending a whole fortnight among the dead. He was ultimately rewarded by obtaining a grave for his hero's remains in Westminster Abbey. John Hunter was his typical hero. He had pursued the studies to which Mr. Buckland also devoted himself. He had founded a great museum. He had almost originated a science. Like John Hunter, one of Mr. Buckland's main objects was to form a collection which would illustrate the whole science of fish-culture. The museum at South Kensington, which he has left to the nation, exists as a proof of his success. Inferior, of course, to the similar collections in the Smithsonian Museum of the United States, it forms an unequaled example of what one man may accomplish by energy and industry. Thousands of persons have interested themselves in fish-culture from seeing the museum; and the collection has long formed one of the most popular departments of the galleries at South Kensington.

Energy was only one of Mr. Buckland's characteristics. His kindliness was another. Perhaps no man ever lived with a kinder heart. It may be doubted whether he ever willingly said a hard word or did a hard action. He used to say of one gentleman, by whom he thought he had been aggrieved, that he had forgiven him seventy times seven already; so that he was not required to forgive him any more. He could not resist a cry of distress, particularly if it came from a woman. Women, he used to say, are such doe-like, timid things, that he could not bear to see them unhappy. One night, walking from his office, he found a poor servant-girl crying in the street. She had been turned out of her place that morning as unequal to her duties; she had no money, and no friends nearer than Taunton, where her parents lived. Mr. Buckland took her to an eating-house, gave her a dinner, drove her to Paddington, paid for her ticket, and left her in charge of

the guard of the train. His nature was so simple and generous that he did not even then seem to realize that he had done an exceptionally kind action.

A volume might perhaps be filled with an account of Mr. Buckland's eccentricities. When he was studying oysters, he would never allow any one to speak; the oysters, he said, overheard the conversation, and shut up their shells. More inanimate objects than oysters were endowed by him with sense. He had almost persuaded himself that inanimate things could be spiteful; and he used to say that he would write a book on their spitefulness. If a railway-lamp did not burn properly, he would declare it was sulky, and throw it out of window to see if it could find a better master. He punished his portmanteau on one occasion by knocking it down, and the portmanteau naturally revenged itself by breaking all the bottles of specimens which it contained, and emptying their contents on its master's shirts. To provide himself against possible disasters, he used to carry with him an armory of implements. On the herring inquiry he went to Scotland with six boxes of cigars, four dozen pencils, five knives, and three thermometers. On his return, three weeks afterward, he produced one solitary pencil, the remnant of all this property. The knives were lost, the cigars were smoked; one thermometer had lost its temper, and been thrown out of window; another had been drowned in the Pentland Frith, and a third had beaten out its own brains against the bottom of a gunboat. No human being could have told the fate of the pencils.

Such were some of the eccentricities of a man who will, it may be hoped, be recollected by the public for the work which he did, and by his friends for his kindliness, his humor, and his worth. As he lived, so he died. Throughout a long and painful illness his spirits never failed, and his love of fun never ceased. "I wish to be present at this operation," was his quaint reply to the proposal of his surgeon that he should take chloroform, and his wonderful vitality enabled him to survive for months under sufferings which would have crushed other men. He is gone: his work is of the past; and posterity will coldly examine its merits. But his friends will not patiently wait the verdict of posterity. When they recollect his rare powers of observation, his capacity of expressing his ideas, his quaint humor, his kindly heart, and open hand, they will say with the writer, we shall not soon look on his like again.—*Macmillan's Magazine.*

THE FELICITY OF NATURALISTS.

THERE is something very charming, especially to sedentary persons, in a sketch such as that of Mr. Frank Buckland, which has just appeared in "Macmillan," from the pen of Mr. Spencer Walpole. It is not that the sketch is at all particularly good as literature; it is as good as it needed to be, but we read a hundred papers as good every year. Nor is it that Mr. Buckland's career was in any way suggestive of any tranquil or attractive sort of idyl. He was a man of business and a man of bustle, knew how to hurry, and from a curious kind of carelessness was very often in the state known as flurry. He could not keep anything he wanted, unless it were alive, and when over-bothered by human stupidity, such as that of the railway officials, who taxed a monkey as a dog and exempted a tortoise as a "hinsect," he could get very hot indeed. He lived a more or less commonplace though very active and useful life, working very hard as Fishery Commissioner, and chief contributor to "Land and Water," and correspondent-general to the practical naturalists of the United Kingdom, making the money he wanted, spending it as he liked, with a good deal of waste of silver, and generally demeaning himself as a valuable and bustling member of the community. He was not of the lotos-eaters, but of the breezy-bodies. The charm lies in the sense which the narrative evokes, that a very happy career, a life in which depression, and low spirits, and trouble generally are unknown, is quite possible to men. We have noticed that specialty in the lives of naturalists very often before, and begin to believe that it is to a quite separate degree peculiar to them. It is not unlikely that it should be so, for many of the great conditions of happiness are present in their lives. It is essential to true happiness to have some pursuit which strongly interests you; and the naturalist has his pursuit, which never tires him, never fails him, and can never come to an end. The author requires subjects and leisure, the painter models, the student books and reasons for study; but the naturalist is always ready, always engaged, always getting his result, even if it be a negative one, and never has the smallest prospect of getting to the end of his occupation. No matter how small may be the subdivision of the natural kingdom to which he attends, it is more extensive than his life will be. Not only does no man know all there is to be known about ants, or spiders, or minnows, but no man hopes to know, except by study of the knowledge of other men also, accumulated through ages. Most men get satiated or "weary," as they put it, of their businesses; but who ever heard of a true naturalist retiring? The longest life, the hardest voyages, the most endless collections, will not satiate the curiosity of a conchologist about the colors, let alone the convolutions and the texture of his brilliant favorites.

No forester knows or will know all the trees of the forest, or, if he does, will know enough of their growth, structure, and climatic conditions of reproduction to be satisfied with himself. No ornithologist ever boasts even to himself that his knowledge of his kingdom, with its wonderfully separate subjects, so unlike all other living things in the grand condition of their lives, is more than fragmentary, or insusceptible of increase. He has never examined all the eagles' eyes, or the angles at which the humming-bird's feathers lie, and therefore flash so unaccountably. Who knows all about lions, or can prove whether or no the wild beasts' rage is an evolution from hereditary hunger continued through ages? Mr. Buckland attended to fish principally, fish from sharks to minnows, and collected, it is said, five thousand specimens, and was always hurrying about inspecting, or receiving, or writing about, new fishes; but, if he had lived a thousand years, he would not have exhausted his pursuit. There would have been still much to know about varieties of gills, and fins, and scales, and more about the fish which could or could not be cultivated; and when that had been done there would remain the inexhaustible and bewildering subject of the comparative intellectual capacity of different fishes. Do carp know their friends or not? A pursuit always so fresh, always so inexhaustible, and always so full of results, is one high condition of happiness; and it has occasionally, and might have oftener this addition—that the naturalist may live by it. Happy the man who in earning his living is in his groove of work, who feels that his faculties are not twisted or repressed by his daily labor, and has in his hardest toil pleasure; but what is his happiness to the naturalist's who earns his income in his play? Imagine the street-boy to whom hopscotch brings a reputable and sufficient subsistence, and yet who can never be tired of hopscotch! Mr. Buckland, curious in fish, and fond of open air, and of traveling about, and of fidgeting in briny places, was set to inspect fisheries, and instruct fishermen, and write about fish in "Land and Water," and tell mankind generally anything it might want to know about fishes, and all the while was adding to his own store and the world's store of knowledge of a subject which he justly thought great, and got by doing all that an excellent income. What wonder that he was happy and cheerful, and given to jocularities, sometimes very clever, sometimes only whimsical, occasionally a little foolish; and had in him a most attractive element of childlikeness, which even secluded fishermen, jealous of the "Government chaps," and half dreading either interference or fines, found it impossible to resist? They "cottoned" to him always, like dogs to a fearless child. Mr. Buckland could have induced Irish fishermen to fish without bounties, a feat supposed impossible; and the magnet in him was the naturalist's magnet, Audubon's, or White's, or Waterton's magnet, the charm of a nature full of the content which springs from harmony between interest and occupation. The man is fortunate who lives in the open

air and amid natural beauties, but the naturalist is never out of them; he is lucky who adds aught to the knowledge of his fellow-man, but the naturalist can not stir without making an addition to it; he is most favored whose occupation forces him to think of greater things than itself, who, like the astronomer, must, in order to learn, for ever look upward—and where is the naturalist without ever-present piety of some kind? It is very comic to hear that Mr. Buckland rejected evolution, because "my father was Dean of Westminster; I was bred in the principles of Church and state, and I will never admit it"; but the thought which prompted that half-humorous, half-serious expression of his faith was not comic at all. He could not, as naturalist, stand a theory which struck him (quite erroneously) as dispensing with, or even affronting, a sentient First Cause. The child in him —which in Mr. Buckland, as in every man who loves Nature with a single heart, was very strong—revolted, and grew pettish.

There is something, however, in the naturalist's pursuit besides happiness which gives him his tribal qualities, those always found with his pursuit, and it is a little difficult to decide quite satisfactorily what it is. It is not the pursuit of knowledge in itself. Scholars and metaphysicians, and men of the sciences which relate to other things than outdoor nature, physicians, for instance, and electricians, are not like the naturalists at all. Indeed, we do not quite know why the pursuit of knowledge of itself should tend to good any more than any other indulgence of curiosity. Nor is it all the open air, for the men who next to the naturalists live most in that, agricultural peasants, belong to a far removed type of men. Nor is it a certain innocence and permanent absence of sinister temptation which attaches to the pursuit, for many pursuits—antiquarianism, for instance—are quite as innocent yet evolve a totally different order of mind, a mind often very much more reflective and less simple. Naturalists, too, are of necessity incessantly killing, and constant though innocent killing seems, as in butchers, rather to brutalize than to refine the general character. Butchers' boys are not breezy people at all, nor, for that matter, are fishmongers or poulterers. The goodness of naturalists, like the serenity of Arctic voyagers, is of a kind *per se*, a quality which we scarcely discover in any other class, a benevolence quite unfailing and almost Christlike in persons otherwise very human indeed.

May it not be that the instinct of mankind is true—that Nature, an undeteriorated work of God, has in it something better than man, and in close contact with the mind gives that something out? It may be said that we do not find this result in the savage, even if he be Hawaian or Guacho—that is, even if he lives always amid scenes of unfailing beauty; but that is because the savage's mind is closed to the necessary contact. But we do find it in the sportsman, who, even if in other ways objectionable, or even brutalized by the constant and objectless slaughter of things more beautiful than himself, has often in

him something of that which we find in a higher degree in naturalists, and which comes to all who can receive it from contact with Nature face to face. Very dreamy, all that! Very true; but, if we never dream, there are large regions of thought of which we shall understand nothing, for in them only hypothesis and sympathy can possibly be our guides.—*Spectator.*

PLANTATION FOLK-LORE.*

By Professor T. F. CRANE.

IN a passage in his recent essay on Hawthorne, which was received with some disfavor by his countrymen, Mr. James enumerated the "items of high civilization which are absent from the texture of American life." To these might be added an item of low civilization, but what, for the purpose of the imaginative writer, is of greater utility than the court or Epsom—folk-lore. With the exception of a few legends of the Hudson due to the Dutch, and an occasional Indian legend (generally manufactured by the white man), there are no local legends from one end of the land to the other. In minor matters, such as superstitions, the case is no better; aside from the aversion to Friday, and sitting thirteen at table, we know of no general superstition. There are, however, two classes of native Americans which must be exempted from the application of the above rule—the Indians and the Southern negroes. The superstitions of the latter, chiefly religious, have been darkly hinted at from time to time, and have occasionally afforded slight contributions to fiction; a few, the reader will remember, are to be found in Mark Twain's amusing book, "Tom Sawyer."

It was not suspected that the negroes possessed a large fund of one of the most entertaining classes of popular tales—animal stories—until a number were published in the "Riverside Magazine" (November, 1868; March, 1869), "taken down from the lips of an old negro in the vicinity of Charleston," variants of which appeared in the New York "Independent" (September 2, 1875), and from time to time in other papers. The first attempt at anything like a full or complete collection of these tales is in the book before us, which is not only a most entertaining and novel work but a valuable contribution to comparative folk-lore. The volume is divided into "Legends of the Old Plantation" and "Uncle Remus's Songs and Sayings." In addition to these there are some proverbs and "A Story of the War." The true value of the book, however, is in the thirty-four inimitable "Legends of the Old Plantation," which are related night after night by an old negro to the little

* Uncle Remus. His Songs and his Sayings. The Folk-Lore of the Old Plantation. By Joel Chandler Harris. New York: D. Appleton & Co., 1881.

grandson of his former owner. Too much praise can not be bestowed upon Mr. Harris for the manner in which he has executed his task: not only is the representation of the dialect better than anything that has heretofore been given, but he has shown himself a master in the difficult art of collecting popular tales. A glance at the variants of these stories published elsewhere will show the vast superiority of Mr. Harris's. It is not, however, in their literary character, interesting as it is, that we intend to examine briefly these fables, but simply in their relations to the similar tales of other countries.

Mr. Harris does not state the precise locality where he collected his fables. To cite the words of a competent critic ("The Nation," December 2, 1880): "Presumably his stories are all of Georgian origin, though he cites a variant from Florida; and he gives us proof that 'they have become a part of the domestic history of every Southern family.' However widely they may have been spread through our domestic slave-trade, we regard it as highly probable that the Sea-Island neighborhood from South Carolina to Florida was, as in the case of the slave-songs, the focus of the animal fables—an hypothesis which finds its support in the reference of both to an African and heathen origin." We have at present but scanty information as to the extent of the diffusion of these stories—variants have been found in South Carolina and Florida; no locality is mentioned for those given in the interesting article on "Folk-Lore of the Southern Negroes," by William Owens, in "Lippincott's Magazine," December, 1877, pp. 748–755.*

These stories narrate the contests of wit between the rabbit, the terrapin, the bear, the wolf, and the fox. The first two, who are the embodiments of weakness and harmlessness, are always victorious; as Mr. Harris says, "It is not virtue that triumphs, but helplessness; it is not malice, but mischievousness." The animals are all dignified with the title *Brer*, or *Buh*, as represented by Mr. Owens, who says, "It is generally supposed to be an abbreviation of the word 'brother'" (the *br* being sounded without the whir of the *r*), "but it probably is a title of respect equivalent to our Mr." The manners and customs of human beings are, after the usual fashion of fables, transferred to the animals in a way that excites the wonder of Uncle Remus's youthful auditor, and a mysterious Miss Meadows and "de gals" are introduced, with whom the animals are on terms of intimacy, and at whose house some of the most amusing incidents take place. A glance at the contents of these fables will at once reveal many familiar episodes, a few of which we shall note for a specific purpose.

In No. XVI, "Old Mr. Rabbit he's a Good Fisherman," Brer Rab-

* There are four stories in this article which have no parallels in "Uncle Remus": "Buh Rabbit, Buh Wolf, and the Pears"; "Buh Rabbit frightens Buh Wolf"; "The Rooster and the Cornbread;" and "Buh Elephant and Buh Lion," which last has a distant resemblance to a story in Koelle's "African Native Literature," London, 1854, p. 177.

bit, while the Fox, Coon, and Bear are clearing up "a new groun' fer ter plant a roas'n' year patch," slips away and hunts for a cool place to rest in. He finally came across a well with a bucket hanging in it and looking so cool that Brer Rabbit climbed in, and of course the bucket began to descend; "but Brer Rabbit he keep mighty still, kaze he dunner w'at minnit gwineter be de nex'. He des lay dar en shuck en shiver." The Fox saw the Rabbit slip away and followed him, and his amazement can be imagined when he saw the Rabbit disappear down the well. The Rabbit on being asked, "Who you wizzitin' down dar?" answered that he was fishing, and invited the Fox to get into the other bucket and come down and help him. This the Fox did, and as he went down up went Brer Rabbit. The Fox is afterward pulled up by the owner of the well and escapes. This fable will be recognized at once from the familiar version in La Fontaine (XI, 6, "Le Loup et le Renard"), which he took from the "Roman de Renart." A much older version is found in the "Disciplina Clericalis," a collection of Oriental stories made in the first years of the twelfth century.

No. XVII, "Mr. Rabbit nibbles up the Butter," relates how Brer Rabbit, Brer Fox, and Brer Possum laid up their provisions together in the same shanty, and put the butter that Brer Fox brought into the spring-house to keep it cool. Brer Rabbit, however, under the pretense of going to see his family, leaves his companions at their work and takes a nibble at the butter. This goes on until the butter disappears, and, while the others are sleeping, Brer Rabbit smears Brer Possum's mouth with the butter on his paws. Brer Possum on waking up was naturally indignant, and demanded an ordeal by fire to prove his innocence, but, as ordeals among men even must sometimes have failed, the innocent Possum is burned up, greatly to the indignation of Uncle Remus's listener. With this story may be compared Grimm, No. 2, "The Cat and the Mouse in Partnership." A closer parallel is found in W. H. I. Bleek's "Reynard the Fox in South Africa; or Hottentot Fables and Tales" (London, Trübner, 1864, p. 18), "Which was the Thief?"

"A Jackal and a Hyena went and hired themselves to a man to be his servants. In the middle of the night the Jackal rose and smeared the Hyena's tail with some fat, and then ate all the rest of it which was in the house. In the morning the man missed his fat, and he immediately accused the Jackal of having eaten it. 'Look at the Hyena's tail,' said the rogue, 'and you will see who is the thief.' The man did so, and then thrashed the Hyena till she was nearly dead."

In No. XXV, "How Mr. Rabbit lost his Fine Bushy Tail," the Rabbit is victimized by the Fox, who persuades him to fish, one cold night, by dropping his long, bushy tail (rabbits formerly had such) into the water. It freezes fast, of course, and the poor Rabbit to get away is obliged to leave his tail in the ice. This is one of the familiar episodes in the "Roman de Renart."

Some of the stories contain incidents which are common to European popular tales, as in No. XX, "How Mr. Rabbit saved his Meat." Brer Wolf suspected Brer Rabbit of stealing some of his fish, and killed Brer Rabbit's best cow. The latter frightened the Wolf away by telling him that the "patter-rollers" (patrol, policemen) were coming, and proceeded to skin the cow and salt down the hide and stow away the carcass in the smoke-house. The end of the cow's tail he stuck in the ground, and called Brer Wolf. "Run yer, Brer Wolf, run yer! Yo' cow gwine in de groun'!" When Brer Wolf arrived, he found Brer Rabbit holding the tail with all his might to keep the cow from going into the ground. Brer Wolf caught hold, and off came the tail. The Wolf was not going to give the matter up so, and got a spade, a pick-axe, and a shovel, and began to dig for his cow, while Brer Rabbit sat on his front-porch smoking his cigar and watching him. This episode is found in a Basque story (Webster's "Basque Legends," p. 10) and in an Italian tale ("Jahrbuch für roman. und eng. Lit.," VIII, 252), and in many others that we have not space to mention.

No. XIII, "The Awful Fate of Mr. Wolf," relates how the Wolf persecuted Brer Rabbit, and carried off some of his family. To protect those left, "Brer Rabbit b'ilt 'im a straw house, en hit wuz tored down; den he made a house outen pine-tops, en dat went de same way; den he made 'im a bark house, en dat wuz raided on; en eve'y time he los' a house, he los' wunner his chilluns." Finally, he built a plank house with rock foundations, and then could live in peace. One day the Wolf, pursued by dogs, took refuge in Brer Rabbit's house, and begged him to hide him from the dogs. The Rabbit told him to get into a chest, and, the Wolf once secure, the Rabbit bored holes in the top of the chest, and poured boiling water in and scalded the Wolf to death. A similar story, except that seven Pigs and a Fox take the place of the Rabbits and Wolf, is told by Mr. Owens ("Lippincott," December, 1877, page 753), who cites as a parallel the Anglo-Saxon story of "The Three Blue Pigs." Another parallel may be found in a Venetian story (Bernoni, "Tradizioni Popolari Veneziane," p. 69, "El Galo").

One of the incidents in No. XX, "A Story about the Little Rabbits," is also familiar, and seems like a curious metamorphosis of a well-known trait of fairy tales. The Fox goes to Brer Rabbit's house, and the sight of the fat little Rabbits makes his mouth water, and he endeavors to invent some excuse for killing them. He finally sets them difficult tasks to do, intending to devour them if they fail; but a little Bird on top of the house sings the solution of all the difficulties, which are: to break off a piece of sugar-cane; to bring water in a sieve; and to put a big log on the fire. The second task is the one found in European folk-lore, an example occurring in another Venetian story (Bastanielo, Bernoni, "Fiabe," No. 6).

One of the most amusing stories in "Uncle Remus" is No. II, "The Wonderful Tar-Baby Story" (versions also in "Riverside Magazine," 1868, p. 505, and "Lippincott," December, 1877, p. 750), in which the Fox made "a contrapshun wat he call a Tar-Baby," out of tar and turpentine, and put it in the way of the Rabbit, who got stuck to it, and thus fell into the Fox's clutches. In the "South-African Folk-Lore Journal," I, p. 69, there is a curious parallel to the above story. A number of animals build a dam to hold water, and the jackal comes and muddies the water. A baboon is set to guard the dam, but the jackal easily outwits him. Then the tortoise offers to capture the jackal and proposes "that a thick coating of 'bijenwerk' (a kind of sticky, black substance found on beehives) should be spread all over him, and that he should go and stand at the entrance of the dam, on the water-level, so that the jackal might tread on him, and stick fast." The jackal is caught, but, with his customary craft, escapes.

In the last of Uncle Remus's stories, No. XXXIV, "The Sad Fate of Mr. Fox," the Fox and the Rabbit jump down the mouth of a cow and help themselves to meat, the Fox warning the Rabbit not "to cut 'roun' de haslett." The Rabbit disobeys the injunction, and the cow falls dead. The owner cuts her open to see what was the matter, and the Rabbit betrays the Fox, who was hiding in the "maul," and who is thereupon killed. In Bleek, p. 27, the Elephant and the Tortoise have a dispute, and the former determined to kill the latter, and asked him, "Little Tortoise, shall I chew you or swallow you down?" The little Tortoise said, "Swallow me, if you please!" and the Elephant swallowed it whole. After the Elephant had swallowed the little Tortoise, and it had entered his body, it tore off his liver, heart, and kidneys. The Elephant said, "Little Tortoise, you kill me." So the Elephant died; but the little Tortoise came out of his dead body and went wherever it liked.*

More remarkable, however, than the above casual points of resemblance is the substantial identity of these stories with those of a tribe of South American Indians. In 1870 Professor C. F. Hartt heard, at Santarem on the Amazons, from his guide in the *lingua geral*, a story, "The Tortoise that outran the Deer," a version of which he afterward published in the "Cornell Era" (January 20, 1871), and which attracted the attention of a writer in "The Nation" (February 23, 1871), who gave a variant of the same myth, as found among the negroes of South Carolina (the same story occurring in "Uncle Remus," p. 80).

* Mr. Harris includes among the animal fables a story which properly does not belong there, and which is nothing but a well-known European tale which Uncle Remus must have heard from the whites, although Mr. Harris, p. 136, note, says, "This story is popular on the coast and among the rice-plantations, and, since the publication of some of the animal-myths in the newspapers, I have received a version of it from a planter in southwest Georgia." The story in question is No. XXXII, "Jacky-my-Lantern," and is nothing but a version of the French story of "Bonhomme Misère," which is of Italian origin. (See Pitrè, "Fiabe," Nos. 124, 125; De Gubernatis, "Novelline di Sto. Stefano," No. 32, etc.)

This singular resemblance does not seem to have been noticed again until Mr. Herbert Smith, in his "Brazil, the Amazons, and the Coast" (New York, Charles Scribner's Sons, 1879), in a chapter devoted to "The Myths of the Amazonian Indians," gave a number of animal fables, but, owing to his insufficient acquaintance with comparative folk-lore, he was unable to throw any light on the subject, merely noticing the resemblances which had already attracted the attention of Professor Hartt and others. The proof-sheets of this chapter were sent to Mr. Harris, who at once saw that the similarity extended to almost every story quoted by Mr. Smith, and some are so nearly identical as to point unmistakably to a common origin; but when and where? Mr. Harris asks, "When did the negro or the North American Indian come into contact with the tribes of South America?"

Before examining this question, it may be well to compare hastily the stories in Hartt's "Amazonian Tortoise Myths" (Rio de Janeiro, 1875) and Smith's "Brazil" with their parallels in "Uncle Remus" and elsewhere. First, let us examine the stories common to Hartt, Smith, and Uncle Remus:

I. "How the Tortoise outran the Deer" (Hartt, p. 7; Smith, p. 543, gives the version in Hartt, saying: "I quote Professor Hartt's words for this story, as being better than the version, substantially the same, that I find in my note-book. The story is very common all over the Amazons."—"Riverside Magazine," November, 1868, p. 507; "Cornell Era," January 20, 1871; "Nation," February 23, 1871, p. 127; and "Lippincott's Magazine," December, 1877, p. 751). The Tortoise declares that it can outrun the Deer, and the latter challenges it to a race. The Tortoise secretly posts members of its family along the course, who answer for him when the Deer asks if he is ahead. The race begins, and the Deer is so bewildered at hearing the Tortoise's voice always ahead of him, that he runs against a tree and falls down dead. In "Uncle Remus" the Rabbit takes the place of the Deer, and the story ends with the Terrapin's victory without the death of his rival. In "Lippincott" the actors are Buh Rabbit and Buh Frog; but the writer remarks that another version makes the competitors Buh Deer and Buh Cooter (the Negro name for terrapin, or land-tortoise). A German version of this story is given in the "Riverside Magazine," September, 1868, and a version from Siam may be found in the "Orient und Occident," III, 497. A more important and significant parallel, however, is to be found in Bleek, No. 16, p. 32, "The Tortoises hunting the Ostriches": "One day, it is said, the Tortoises held a council how they might hunt Ostriches, and they said: 'Let us, on both sides, stand in rows near each other, and let one go to hunt the Ostriches, so that they must flee along through the midst of us.' They did so, and, as they were many, the Ostriches were obliged to run along through the midst of them. During this they did not move, but, remaining always in the same places, called each to the

other, 'Are you there?' and each one answered, 'I am here.' The Ostriches, hearing this, ran so tremendously that they quite exhausted their strength, and fell down. Then the Tortoises assembled at the place where the Ostriches had fallen, and devoured them."

II. "How the Tortoise provoked a Contest of Strength between the Tapir and the Whale" (Hartt, p. 20; Smith, p. 545; "Uncle Remus," p. 111). In Hartt, a Tortoise went down to the sea to drink, and a Whale made sport of him, but the former said he was stronger than the latter, and could pull him on shore. The Whale laughed, but the Tortoise went into the forest to get a long root, and, while, looking for it, met a Tapir, who asked him what he was doing. The Tortoise replied that he was looking for a root to pull the Tapir into the sea with. The Tortoise found his root, and tied one end to the Tapir and the other end to the Whale (of course, both remaining in ignorance of the performance); the two then tugged against each other, and finally gave up the struggle from sheer exhaustion. In another version (p. 23) the *cobra grande*, or mythical great serpent, and the jaguar are made to pull against each other in the same way. Smith mentions a version he himself heard, and then gives Professor Hartt's. In "Uncle Remus" Brer Terrapin brags that he can out-pull Brer Bear, and, borrowing Miss Meadows's bed-cord, he gives one end to the Bear, and, diving down into the water, fastens his own end to a big root, and the Bear soon gives up pulling against Brer Terrapin.

III. In a version of another story, "How a Tortoise killed a Jaguar" (Hartt, p. 29; Smith, p. 542; "Uncle Remus," p. 60), the Jaguar is represented as reaching down into the burrow and catching hold of the Tortoise, who, resisting, calls out, "Oh, you foolish fellow! you think you have caught me, when it is only the root of a tree you have secured." In "Uncle Remus," the Fox, in revenge for what will be told in the following story, determines to kill Brer Terrapin. The latter begs piteously not to be drowned, and the Fox, taken in by this, souses him into the water, still holding on to him, when the Terrapin "begin fer ter holler, 'Tu'n loose dat stump, en ketch holt er me.' Brer Fox he holler back, 'I ain't got holt er no stump, en I is got holt er you.'" But at last he was deceived by the Terrapin's cry that he was drowning, and let go of him.

IV. In the last-mentioned story, "How a Tortoise killed a Jaguar" (Hartt, p. 26; Smith, p. 541; for one incident only, "Uncle Remus," p. 52), a Monkey carried a Tortoise up into a palm-tree to eat the fruit. When his hunger was satisfied, the Tortoise wished to descend, but the Monkey had gone, so the Tortoise had to remain there until a Jaguar came along and asked him why he didn't come down. The Tortoise said he was afraid, but the Jaguar said: "Don't be afraid! Jump! I will catch you!" Then the Tortoise jumped down and struck the Jaguar on the head and killed him. In Mr. Smith's version, collected at the same place (Santarem), the Tortoise, after throw-

ing the Jaguar down some fruit, slips off the tree, and, falling on the Jaguar's head, kills him. In "Uncle Remus," while the Rabbit and Terrapin are calling at Miss Meadows's, the Fox comes in on them unawares, and the Terrapin, who has been put up on a shelf, rolls off in his agitation, falls on the head of the Fox, and stuns him a moment, so that Brer Rabbit escapes.

These are all the stories in Hartt which have full or partial parallels in "Uncle Remus"; there are, however, several additional ones in Smith that belong here.

V. "Story of the Jaguar who wanted to marry the Deer's Daughter, but was cut out by the Cotia" (Smith, p. 547; "Riverside Magazine," 1868, p. 505; "Lippincott's," 1877, p. 753; and "Uncle Remus," p. 34). The Cotia brags that he can ride the Jaguar, and the Deer promises to give him his daughter if he does. The Cotia pretends to be ill, and the Jaguar charitably takes him on his back, and even ties him on with a root, and gives him a switch. When the Cotia finds himself master of the situation, he whips the Jaguar unmercifully, and rides him by the Deer's house. In "Lippincott" the Rabbit and Wolf, in the other versions the Rabbit and Fox, are the parties concerned.

VI. In the conclusion of Smith's version, p. 549, the Cotia slipped off the Jaguar's back, and hid in a hole before the latter could catch him. The Jaguar set an Owl to watch the hole, but the Cotia peeped out and threw a handful of sand in the Owl's face and ran away. A somewhat similar incident is found in "Uncle Remus," p. 39 ("Riverside Magazine," 1868, p. 506, III, at end), but, instead of throwing sand in the Buzzard's eyes, the Rabbit makes him believe that there is a squirrel in the tree in which the Rabbit is imprisoned, and, when the Buzzard rushes around to catch it, the Rabbit escapes.

VII. "Story of the Cotia who played Tricks on the Jaguar and outwitted him" (Smith, p. 549, at end). The Jaguar, enraged at the tricks played upon him by the Cotia, caught the latter and tied him to a tree, intending to drown him in the morning. The Cotia expressed his joy at this determination, and remarked that he would be very sad if he was going to be thrown into a brier-bush. The Jaguar, of course, changed his mind and threw his enemy into a brier-bush; whereat the Cotia ran away laughing. The same incident precisely occurs in "Uncle Remus," p. 29 ("Riverside Magazine," 1868, p. 505, I), with the Fox and the Rabbit, who begs, "fer de Lord's sake, don't fling me in dat brier-patch!" The Fox is again deceived, and the Rabbit, as he escapes unhurt, cries out, "Bred en bawn in a brier-patch, Brer Fox!"

VIII. A variant of the last story(Smith, pp. 552, 554) relates that, to be avenged on the Cotia, the Lion and Jaguar guarded a spring, so that the Cotia could get nothing to drink. After a time the Cotia became very thirsty, and, seeing a man pass with a jar on his head, said to himself, "I will see if I can get some water from

that jar." So he ran ahead of the man and lay down in the path. The man thought it was a dead Cotia, and shoved it aside with his foot and went on. This the Cotia repeated four times, and at last the man said: "Here's another dead Cotia! Now, I will go back and get the others, and carry all four home." He put down the jar and went to look for the other Cotias. Then the Cotia jumped up and thrust his head into the jar, which contained molasses instead of water. In "Uncle Remus," p. 70, the Rabbit, by a similar stratagem, steals Brer Fox's game. Mr. Smith, p. 558, note, mentions a parallel to this story from Egypt (Khunzinger, "Upper Egypt, its People and its Products," p. 401). I do not recall any parallel in which animals are the actors; but a similar trick is found in many versions of the story of "The Master Thief," for instance, in Asbjörnsen and Moe's "Norske Folke-Eventyr," No. 34, "Mestertyven."

We are prepared now to consider briefly the origin of these stories, which are substantially the same in Brazil and in the Southern States. That the negroes of the United States obtained these stories from the South American Indians is an hypothesis no one would think of maintaining; but that the Indians heard these stories from the African slaves in Brazil, and that the latter, as well as those who were formerly slaves in the United States, brought these stories with them from Africa is, we think, beyond a doubt, the explanation of the resemblances we have noted. Owing to a scarcity of materials, we have not been able to show very clearly the African origin of these stories, but what we have cited makes it at least probable. Whether the African stories of "Reynard the Fox" are original with the Hottentots, or have been communicated to them by the Dutch, is a point we can not decide, in the absence of more ample material for comparison.

The most interesting point in the present investigation, and one that connects it with the recent discussions on the subject of folk-lore, is that, if our explanation be true, it shows that popular tales are more readily diffused than has heretofore been supposed. Professor Hartt ("Amazonian Tortoise Myths," p. 5) says: "The question has arisen, whether many of the stories I have given, that bear so close a resemblance to Old World fables, may not have been introduced by the negroes? But I see no reason for entertaining this suspicion, for they are too widely spread, their form is too thoroughly Brazilian, they are most numerous in just those regions where negroes are not and have not been abundant, and, moreover, they occur, not in Portuguese but in the *lingua geral*." The first objection would simply show the extent of the diffusion, the second what would naturally take place on the introduction of stories from a country with a different fauna, and the final objections were overthrown, we believe, by Professor Hartt's hearing these same stories from the negroes in Rio. He gave up the hypothesis of an Indian origin, and did not continue his collection. Mr. Smith (p. 548) makes about the same objections, which are invali-

dated by the writer's own admissions: "They are repeated in remote provinces, among half-wild tribes who *hardly* (the italics are ours) ever see the negroes. . . . Many of the tortoise myths are told by the Mundurucú Indians, the *majority* of whom can not speak Portuguese." Mr. Smith also confirms, what has been said above, that these stories are told in Rio by the negroes, and a very suspicious circumstance is the introduction of a lion into one of the stories (p. 551), which, as Mr. Smith remarks, "shows that the narrator had heard of lions, probably from the slaves."

In taking leave of this interesting subject we must reiterate our praise of Mr. Harris's charming volume, and we trust that its scientific side may not be overlooked, but awaken an interest in negro folk-lore which will result in other works as entertaining and valuable as "Uncle Remus."

AN ANCIENT SCIENTIST.

READERS of Mrs. Browning will remember in the "Vision of Poets" the description of Lucretius, as one

> "Who dropped his plummet down the broad,
> Deep universe, and said, 'No God,'
>
> "Finding no bottom. He denied
> Divinely the Divine, and died
> Chief poet by the Tiber side."

In spite of this high encomium, approved by men of taste in all ages, the subject of this sketch is far less known to fame than many others of much smaller ability either as poets or as philosophers. He is unknown to many, to whom Virgil, Horace, Juvenal, and even Ovid, are household words. And yet, of these four, Virgil alone can contest the palm of supremacy with him. When Tyndall, in his famous Belfast Address, introduced his typical Lucretian as an opponent to Bishop Butler, many well-informed people were driven to their classical dictionaries to discover whom the orator meant.

It is not easy to say what are the causes of this neglect. Lucretius is not only one of the few first-class poets in Latin literature, but he is also one of the most subtile and original thinkers that Rome ever produced. His system shows how far scientific speculation had gone in his day, and what views the most enlightened took in regard to the structure of the universe and the problems of matter and life. His theories are plausible, and sometimes have anticipated modern hypotheses and discoveries. Yet few really know who he was and what his doctrines are. It is to supply this wanting knowledge—to show what

relation Lucretius actually bears to science—that this summary of his principles was written.

Titus Lucretius Carus was born 96 B. C., and was thus the contemporary of Cicero, Cæsar, and Sallust. As with many other great men, little of his personal life is known. It appears that in his youth he studied philosophy at Athens in company with Cicero and other Romans afterward distinguished in politics and literature. Beyond this we know nothing certain of his life. He died B. C. 52, while Horace was still a schoolboy at Rome and Virgil had just reached the age of manhood. There is a story that his wife, fearing a decrease in his affection toward her, had given him a love-philter, which made havoc with his brain, and filled his mind with base thoughts, so that sooner than endure them he killed himself. This version of his death is well known through Tennyson's poem "Lucretius"; it, however, is a matter of tradition, and not of history.

From his life we now turn to his great work, "The Nature of Things." In this he lays down the whole system of the Epicurean philosophy, a system which has been more vilified and misrepresented than any other put forth by man. Its physical basis was the atomic theory, which was first promulgated by Leucippus. The real founder of the school was Democritus of Abdera, to whom Bacon awards a high place among great thinkers. The great exponent of these doctrines was Epicurus, from whom the system takes its name. He lived mostly at Athens in the third and fourth centuries before Christ, and was noted for his frugal and virtuous life. His moral principles did not consist in reckless indulgence of the senses, but in moderation in all things, and in avoidance of pain, whether moral, mental, or physical. This principle is continually set forth and illustrated by Horace, especially in his "Satires." In him the tenets of the Epicurean philosophy become the maxims of a prudent, intelligent man of the world.

But it is with the scientific aspect of this system, as set forth by Lucretius, that we have chiefly to do. Its principles are contained in six books of twelve or thirteen hundred lines apiece. It is best to take up the books in their order, as the argument is closely connected throughout.

The first book contains the broad principles of the atomic theory. After a beautiful passage describing the benumbing power of superstition, he asserts that the only means of overcoming this is found in the study of nature, and declares that the difficulty of the task shall not prevent him from attempting it. The first principle which he lays down is, that all matter is uncreated; or, as he expresses it, nothing can spring from nothing. For, if anything can spring from nothing, what need is there of these long processes of birth and growth and these aids to development? Why should all this labor be spent in vain, if anything could become what it is without labor? This is simply

the ordinary scientific argument from experience, and, although not strictly logical, is an expression of the conviction, common to every student of Nature, of the continuity and permanence of physical law. This conviction is not supported by arguments, but is built up slowly and surely by the daily observation of Nature's working and of the never-failing fulfillment of her laws. Our author's reasoning, therefore, is calculated rather to convince the man of science than the mere logician.

Having established this principle, he goes on to state the converse, that matter is never annihilated. For, he argues, since nothing can be created, a continual unreplaced loss would have been going on, which in the infinite course of past time would have left nothing of the universe at all. Here, again, he shows that he has the scientific conviction of the uniformity of nature. An objector might have said, "Though there has been no loss, no annihilation in time past, how do you know that there will be none in time future?" This argument, though unanswerable, is incapable of producing conviction in a scientific mind. Such an argument, as Tyndall remarks in his "Fragments of Science," is employed by the spiritualists in regard to the sun's failing to rise on the morrow. "Before such a state of mind," says he, "the scientific intellect is absolutely powerless." The convictions that rise from uniform experience in the pursuit of physical studies are unassailable by any reasoning short of a mathematical demonstration.

Lucretius adds that, in many cases of apparent annihilation, matter is but lost to grow again in another form. He instances the rain whose drops fall upon the ground and are scattered, but appear again in the blooming tree which shelters beneath its branches flocks and herds and the race of men. Here, as often with this poet, a beautiful episode crops out in the midst of his philosophical argument. Indeed, it is one of his characteristics, and forms his claim to be considered a great poet, that, combined with his appreciation of the order and continuity of nature, he has a fervent love for all its aspects of beauty and life. Often he turns aside to tell of frisking lambs and babbling brooks, and trees that spread their branches far and wide. He seems to have loved nature in all its forms, and to have devoted to it all the wealth of his intellect and imagination. He closes this argument with the celebrated saying, "Nature builds up one thing by means of another, and suffers nothing to be born except another die."

These two propositions, that nothing is created and nothing destroyed, are the primary postulates upon which as a foundation he builds the whole theory of atoms. His first step is to show that there are bodies, which, though invisible, are yet appreciable through the senses. The air, he argues, must consist of solid particles in as true a sense as water, for water itself can not produce greater effects than violent winds. There are, too, other particles of matter which affect

the other senses, but not that of sight. This is proved by the sensations of sound, heat, and smell, which must be produced by matter, for to give rise to the feeling of touch is the essential property of matter and of matter alone. This property is what he calls an *officium corporis*—that is, a "function of substance"; another which he mentions afterward is weight, or the tendency to proceed downward. He also demonstrates the presence of aqueous vapor in the air by the phenomena of absorption and evaporation. A quotation of his language at this point will give a fair idea of his logic and his style: "In short, garments hung on the surf-beaten shore grow moist, but if spread out in the sun they become dry again. Yet we have not seen how the moisture of the water made its way in, nor how it vanished beneath the heat. The water, then, is scattered into minute parts, which the eyes can in no way behold." He employs arguments that are in use nowadays in physics to prove the smallness to which matter can be subdivided. The most solid bodies, such as rings upon the fingers and the very stones beneath our feet, are worn away by constant rubbing. "But," as he goes on to say, "the nature of sight has enviously shut off the view of those portions of the substance which disappear at any one time."

The arguments which he uses in this connection form an additional proof of the scientific tendency of Lucretius's mind. In his time the inductive and experimental methods were imperfectly understood and little practiced. He himself does not appear to have attained to them, he was bound by the false philosophical notions of the Greeks; yet often, as here, he traces the cause from various effects with considerable sagacity. He has in several cases, though generally on insufficient evidence, anticipated some of the results of modern research. It is easy to see how his opinions would have been strengthened, and what added breadth and vigor of reasoning he would have gained, if he had stood on our vantage-ground and had known all that we now know. As it is, we feel surprised at finding that he accomplished so much with such imperfect material for his work.

We do not intend to follow the entire development of his theory, but merely to trace his relations to science and the scientific spirit. The rest of the first book and the whole of the second are taken up with a description of the action and properties of the primitive atoms, of which he supposes all things to be composed. Amid some arguments that appear reasonable, he brings forward a striking fallacy. "If," says he, "matter is infinitely divisible, the greatest and the least, consisting equally of an infinite number of parts, must be equal." In other words, a mile and an inch are equal, for they each consist of an infinite number of equally small parts. The mathematical imagination among the ancients must have been very little developed, if such an argument passed muster with minds trained to the investigation of abstract truth.

On the other hand, Newton, perhaps the most exact thinker known to scientific history, has expressed opinions on the constitution of matter closely resembling those of Lucretius. The latter asserts that all substance consists of atoms, which are perfectly solid, and therefore incapable of being crushed or torn apart; for that which has no void within itself can not be separated into parts: moreover, they are exceedingly hard, for otherwise they could not form hard bodies like iron; yet, when combined with "much void," they can give rise to soft substances, as water and air. Compare this statement with Sir Isaac Newton's belief, as expressed in the following terms: "It seems probable that God, in the beginning, formed matter in solid, massy, hard, impenetrable, movable particles of such size, figures, and with such other properties, and in such proportion to space, as most conduced to the end for which he formed them; and that these primitive particles, being solid, are incomparably harder than any porous body compounded of them—even so very hard as never to wear, or to break in pieces." If we except the belief in the creative power of God, this quotation gives us Lucretius's atomic theory in a nutshell.

Our author is again in harmony with the latest deductions of physics, when he asserts that the atoms have in themselves no sensible properties, such as color, heat, etc. But the arguments which he uses to establish this proposition are by no means convincing. His treatment of the atomic motions, however, is the most vulnerable point in his system. He supposed all constituted things to be produced by the impact of atoms, which through all eternity were descending, urged on by their own weight. Now, Lucretius had very clear ideas on the subject of gravitation. He knew that, except when in a resisting medium, all bodies fall with equal velocities. Hence, in this everlasting, downward rain, it would be impossible for one atom to approach another and combine with it. To obviate this difficulty, he conceived a slight lateral motion, by which the particles are brought together. He offers no reason for this extraordinary hypothesis, except that no other supposition can explain the formation of things *so as to accord with his theory.* It is the old story of system first and facts afterward, and shows well the injurious tendency of the *a priori* method in one who was otherwise well fitted for the pursuit of knowledge.

Passing on to his other teachings, we find him devoting a whole book to the bodily sensations. These, he attempts to show, are produced by corporeal images given off from bodies, and coming into contact with our organs of sense. Thus, he thought that all things were giving off thin pellicles of substance, which, by impinging upon the eye, cause the sensation of sight. This is not unlike Newton's emission hypothesis. His theory of sound also is more purely mechanical than that at present accepted. He supposes this sensation to be caused by the direct passage of particles from the source of sound to the

ear, and seems to have had no idea of motion communicated continuously so as to produce waves. His remarks under this general head are often quite correct, and show that he had some capacity for observation.

When treating of the heavenly bodies, he is ordinarily far out of the way. With him the earth is fixed, and the sun and stars revolve about it. With strange perversity, he denies that the orbs of these bodies can be much larger than they appear, no matter at what distance they are placed. On the other hand, in treating this subject he sometimes displays that suspension of judgment which, as opposed to hasty theorizing, is one of the first characteristics of the careful thinker. He himself says: "I assign a number of reasons, one of which must be true; but which among them is true is not for a cautious man to decide."

He next traces the development of man from savagism to civilization; but, though the account is interesting, it has little to do with his views of physical science, and we therefore pass on to the consideration of the remainder of his work, which treats of various natural phenomena, and explains their causes.

He supposes thunder to be produced by the clashing together of clouds, or by the sudden expansion of a volume of air contained in a cloud. This latter action he compares to the bursting of a bladder. Other causes he enumerates, connected with the effects of winds and lightning, whose action on the clouds may produce sound. Lightning, in his view, is struck out like sparks from flint by the friction of the clouds, or it may be caused by the heat generated by the rapid rotation of a hollow cloud.

His views on the cause of water-spouts are similar to those held by many at the present day, namely, that they originate in the vortex of a whirlwind.

His ideas of the nature of clouds are confused, though in one place, at least, he asserts that they are formed by the combination of vapor which is exhaled from the ocean and the earth's surface. The act of raining he ascribes to the compelling force of the winds and the weight of the clouds themselves.

The opinions which he entertains in regard to earthquakes are specially noteworthy, as having been revived of late years by several scientists to explain some, if not all, of the phenomena attendant upon such convulsions of nature. He supposes these to be caused by subterranean downfalls of large masses of rock.

This view has not only been accepted by a number of modern geologists, but also, as Élisée Reclus * remarks, has been corroborated by many observations. To this author we commend the reader who desires to know the various reasons for accepting the theory.

* "The Earth," chapter lxxiv.

The eruption of volcanoes is referred by Lucretius to the expansion of air heated in the cavities of the earth. Modern theorists would rather explain their occurrence by the expansion of steam under great pressure in some underground passage.

Our author goes on with the explanation of many other phenomena. But he is continually led into error by his desire to accommodate the explanation of the effects to suit his theory. As a specimen, we may quote his view of magnetic attraction. According to the Epicurean belief, all substances gave off pellicles or effluvia, which, as before remarked, were supposed to affect the senses. When, then, a magnet and a piece of iron are brought near each other, the effluvia from the former drive away the air between the two bodies, and particles of iron rush to fill the vacuum so caused. Since these particles are very coherent, they draw the rest of the iron after them. The magnet does not attract gold, because that substance is too weighty; wood, on the other hand, is so porous that the atoms of the effluvia pass through it without difficulty. Amid all these absurdities he seems to have had a really philosophic idea of atmospheric pressure. He says: "The surrounding air is continually dashing upon [bodies]; and it drives the iron forward, under such circumstances [as those mentioned before], because the space on one side is empty, and receives [the iron] into itself." He seems also to have had a crude idea of the modern germ theory of disease, and this idea he dwells upon in the closing portion of his work. He describes the means by which disease is spread, and instances the plague at Athens,* with a magnificent description of which he concludes his poem.

We have traced such of the principles of the author as seem to bear on the relations of ancient to modern science. We see what effect a false method produced in a man of undoubted genius, endowed with a genuine appreciation of nature and a scientific tendency of mind. Anxious for a rational explanation of every part of the wonderful universe that surrounded him, he was not contented with the slow processes of observation and experiment, but hastened to assign the most probable *a priori* causes to everything. And thus, whenever he states a physical truth, he appears to have stumbled upon it quite accidentally. It is no reproach to modern men of science that they have been anticipated in their discoveries by a Roman who lived nineteen centuries ago. Rather, it is their glory that, for the vague intuitions of the poet-philosopher, they have substituted the certainty of demonstration; and, by toilsome study in fields which the ancients either neglected or despised, have gained generalizations far surpassing any of his in grandeur. It is not, therefore, for any discoveries that he made, still less for his method of acquiring knowledge, that we give Lucretius a place in the scientific ranks; it is rather for the high qual-

* Broke out B. C. 430. An accurate account of it is given by Thucydides, from whom Lucretius is thought to have taken his description.

ities of intellect, scientific cast of imagination, and a will that never faltered in the earnest pursuit of truth for its own sake. In every age these are the true characteristics of a man of science.

SKETCH OF MICHEL CHASLES.

"IN the death of Michel Chasles," said M. J. Bertrand, in his funeral eulogy of the deceased mathematician, "France has lost one of its glories, and the members of the Academy of Sciences have lost an excellent friend, who, devoted without reserve to the beautiful studies which made his fame, showed an equal and active kindness to all who traveled in different directions along the highways of science." "As far back as the present generation can remember," says Mr. R. Tucker, in "Nature," "Chasles has been a prince of geometers, and it has come upon many of us as a surprise to hear that he was still walking and working in our midst. . . . To many," says the same writer, "the man who had surpassed in age Leibnitz by seventeen, Euler by eleven, Lagrange by ten, Laplace and Gauss by nine, and Newton by two years, was a '*venerabile nomen*,' but yet a '*nomen*' only."

M. Chasles was born at Epernon, France, November 15, 1793, and died December 18, 1880. His mathematical tastes were exhibited at a very early age; while a pupil in elementary mathematics in the Imperial Lyceum, he was accustomed to communicate to the students in the rival colleges the problems and exercises of each week, asking them, in return, to furnish him the questions proposed by their masters. He entered the École Polytechnique in 1812, and passed out from it with a diploma in engineering in 1814, after having taken his place in the defense of Paris. He was about to go to Chartres to bid farewell to his mother before proceeding to duty at Metz, when he was waited upon by the father of one of his comrades, who asked him to resign in favor of his son, who had failed to obtain a position, pleading that he had made great sacrifices, which he could not afford to repeat, to prepare the youth for a career suited to his taste. Young Chasles made no reply, but went on to Chartres and told his mother he would stay with her. He returned to the École Polytechnique in 1815, but voluntarily renounced public employment, and went to Chartres to spend ten years working quietly at mathematical occupations. "Always," says M. Bertrand, "passionately fond of geometry, he worked out elaborate problems, discovered elegant theorems every day, invented general and fruitful methods, without attracting the attention of the masters of science, or pretending to do so. . . . Without grieving or com-

plaining of his obscurity, or being discouraged by it, he pursued his studies for the love of them, and found glory without having done anything to secure it except to produce great works."

M. Chasles was elected a corresponding member of the Academy in 1839, was appointed Professor of Mechanics and Geodesy in the École Polytechnique in 1841, and was elected the first occupant of the newly created chair of Modern Geometry in 1846. He resigned his position in the École Polytechnique in 1851, in consequence of the introduction into the school of changes of which he did not approve. He was chosen a foreign member of the Royal Society in 1854, was awarded the Copley medal in 1865, and was elected, in 1867, the first foreign member of the London Mathematical Society.

M. Chasles's life was one of active, uninterrupted work in his favorite field, from the time he left the Lyceum till he was eighty-seven years old—a period of sixty-eight years. His contributions of papers to scientific societies and journals are estimated to number nearly two hundred and forty, on subjects which range "over curves and surfaces of the second and any degree, geometry, mechanics (and attractions), history, and astronomy."

Of his greater works—"masterpieces that commanded attention"—the earliest was the "Aperçu Historique," or "Historical View of the Origin and Development of Methods in Geometry," which, says M. Bertrand, "under a title that is more than modest, remains the most learned, the most profound, the most original work that the history of science has ever inspired." It was published in 1830, being an elaboration of a paper contributed several years before to the Royal Academy of Brussels, and was reprinted in 1875, with a preface, giving a short historical account of the book. It is, says Mr. Tucker, a perfect mine of geometrical facts, and is to the present day a high authority on the subject of which it treats.

The courses of lectures delivered by M. Chasles as Professor of Modern Geometry were embodied in 1852 in the "Traité de Géométrie supérieure," or "Treatise on the Higher Geometry," a work which, of late years scarce and high, has recently appeared in a second edition. This was followed by a sequel, a treatise on conic sections ("Traité des Sections Coniques, faisant suite au Traité de Géométrie supérieure," the first volume of which appeared in 1865. The second volume has not been published, but the materials for it have been given from time to time in the "Comptes Rendus."

In 1863 M. Chasles published his "Three Books on the Porisms of Euclid," which was the origin of a short controversy with M. P. Breton. The question of attraction was presented to M. Chasles under several points of view, and gave occasion to a number of memoirs extending even to the consideration of the general problem of the attraction of a body of any form. Poinsot said of one of these papers that it offered a remarkable example of the elegance and light

that geometry could shed on the most obscure and difficult questions; and M. Bertrand has said of them that they gave demonstrations and results admirable as models of elegance and generality.

M. Chasles gained notoriety a few years ago by his connection with a number of manuscripts and autographs purporting to be by distinguished men of the past, among them Galileo, Pascal, Sir Isaac Newton, and even Julius Cæsar and other Roman emperors and the apostles, which he bought of one Irène Lucas and which proved to be nearly all forgeries by that adventurer. Among them were some which claimed for Pascal the merit of Newton's most celebrated discoveries. M. Chasles earnestly defended the authenticity of the documents, of which he was fully and honestly convinced, and was sustained by some eminent members of the Academy, until Lucas was unmistakably shown to have fabricated them. Out of twenty-seven thousand papers which he bought, only about a hundred were genuine.

M. Bertrand, summing up the mathematical work of M. Chasles, says that more than once, without abandoning the geometric method, he "has shown with a rare felicity how all mathematical truths are connected by a close and mysterious bond. We owe to him, in one of the highest and most difficult theories of the integral calculus, elegant theorems admired by analysts; he has added to mechanics a chapter which has become classic on the displacement of solid bodies; he has found in the theory of attraction beautiful and general theorems which have revived the theory of static electricity. . . . All geometricians, without distinction of nationality or school, have bowed before this venerable old man; all have admired his inventive power, his fertility, which age seemed to rejuvenate; his ardor and his zeal continued into his latest days."

LITERARY NOTICES.

FOOD FOR THE INVALID, THE CONVALESCENT, THE DYSPEPTIC, AND THE GOUTY. By J. MILNER FOTHERGILL, M. D., and HORATIO C. WOOD, M. D. New York: Macmillan & Co. 1880. Pp. 150. Price, $1.

THE introduction to this volume is a very important and interesting essay on food in its sanitary relations by Dr. Fothergill, while Dr. Wood compiled the recipes, some three hundred in number. In speaking of our present eating arrangements and culinary combinations, Dr. Fothergill says that they have come about under the guidance of the palate first, and the digestion afterward. They were established before the daybreak of physiological knowledge, and the light of chemistry and physiology can not fail to disturb them. Our food combinations should now be modified by our advancing knowledge of the wants of the organism. By a suitable dietary many maladies may be avoided, and many troubles, as indigestion, biliousness, gout, and diabetes, alleviated or even cured. To the increasing wealth and mental worry of our times, Dr. Fothergill ascribes much of the prevalent biliousness, gout, and visceral disturbance; and also the growing incapacity to digest fat, which has led to the use of artificial digestive agents. Hence the necessity for a cook-book devoted to the food of those out of health, or with feeble powers of digestion.

Dr. Fothergill traces the biliousness and gout so common nowadays to the excessive use of albuminoids in our food. They are requisite for tissue growth and repair, and, when swallowed, are digested mainly in the stomach, passing into the blood, whence they reach the tissues. But the nitrogen, their essential feature, when in combination with hydrogen and carbon, does not readily oxidize, and it is the imperfect oxidation in the liver of this nitrogen of the surplus albuminoids that causes biliousness and the gouty condition. "In biliousness the blood is surcharged with bile-salts of albuminoid descent and nitrogenized lineage; just as much as the lithic acid now known as 'gout-poison,' . . . and it is obvious that in the treatment of biliousness and gout alike it is essential to cut down the albuminoid elements of the food to the minimum of tissue-wants."

To the question why we systematically eat more albuminoid food than we require, Dr. Fothergill replies that there are two very potent reasons: one, because it is pleasant to eat it, and another, because it produces an agreeable mental condition. "The albuminoid waste in the blood gives us the sensation of energy, of being equal to work, which is pleasant to all. But this sensation is bought with a price; and its Nemesis is found in biliousness and gout." After proving the albuminoid descent of both bile and gout-poison, Dr. Fothergill remarks that the amount of albuminoids required for the repair of the tissues of the body is very small, and it is with the intent of avoiding excessive albuminoid waste that the dietaries arranged in the volume consist so little of "brown meats." The flesh of fish, however, is provided for in abundance. More than ninety of the recipes are devoted to the preparation of fish of various kinds in soups, pies, patties, and puddings, or boiled, stewed, fried, broiled, in paste, and on toast. Not that "fish" differs materially from "flesh" in chemical composition, but it contains more water, and is more easily digestible. "A meal of fish," it is said, "gives less albuminoid waste than a meal of brown meats."

Great prominence is given to fat in the dishes here recommended. It is regarded as a most important element of food, and much pains are taken to make it unobjectionable to the palate, inoffensive to the stomach, and easily assimilable by the system. Starch, also, so long decried and sneered at as having no food-value, is given a prominent place. "With fat and starch," Dr. Fothergill declares, "the bilious are comparatively well; for neither can produce bile-acids." They may, however, lead indirectly to the production of bile-acids when eaten in excess.

The first forty-three recipes of the book

are for drinks of various kinds—milk with seltzer-water, with lime, with magnesia, etc., teas, broths, gruels, egg preparations, lemonade, and a long list of variously flavored "waters." When we come to the solid foods, the reader is furnished with a guide to their use by means of initials attached to the recipes. I. stands for invalid, C. for convalescent, D. for dyspeptic, G. for gouty, and E. for economical. When a dish is suitable for all these classes, all these initials are appended to it. Thus, mock *pâté de foie gras* is marked (I. C. D. G. E.), cauliflower (C. G.), scrambled eggs (I. C. D.), while half a dozen recipes for various salads have only the single initial (G.)

Cream is also a favorite element in many of the recipes of this book. Eggs, oysters, fruit, and vegetables abound in them; and, although the title only promises sick-room cookery, we are offered an abundance, and variety that commend the book to everybody, sick or well. Warmed-over meat is condemned, unless the digestion is perfect. One method of preparing it is given as follows: "Mince the meat fine with some pepper and salt; place a wall of well-mashed potato in a pie-dish or soup-plate; put in the minced-meat, and place over it a crust of mashed potato; put in the oven till the meat is warmed through, and not one moment longer." Sandwiches are much approved. Nursery-food is carefully provided for, and excellent general directions are given concerning the serving of food to the sick. The book can not fail to be helpful to families which are seldom quite exempt from sickness or feebleness; and physicians may make it serviceable in providing a full dietary for their patients.

INTRODUCTION TO THE STUDY OF INDIAN LANGUAGES, WITH WORDS, PHRASES, AND SENTENCES TO BE COLLECTED. By J. W. POWELL. Second edition, with Charts. Washington: Government Printing-Office. Pp. 228, with blanks for taking Notes.

THIS work, published under the direction of the Bureau of Ethnography of the Smithsonian Institution, is designed to aid in the collection of data for the examination and comparison of the languages and dialects of the Indian tribes, and to direct the efforts of students among whatever tribe, so that they shall be conducted methodically, and adapted to fit a system embracing the whole subject. The first edition was published in 1877; the present edition embodies the modifications of the plan that have been suggested by the progress that has been made in the study. An alphabet has been prepared which seems to admit of the representation of all the sounds and modifications of sounds that are likely to occur without demanding the use of odd signs or going outside of the cases of a well-stocked English printing-office. A chapter is devoted to the explanation of the manners, customs, articles of dress, ornament, and use, etc., the study of which may throw light upon the main subject, and should be connected with it. This chapter contains also a synopsis of Mr. Lewis H. Morgan's work on kinship and affinity, illustrated by charts showing the relations of kinship for nine generations, and gives the substance of a paper by Mr. J. Hammond Trumbull on the best methods of studying the Indian languages. It is followed by a series of schedules embracing the various subjects of Indian thought which are to be filled up by individual students with details for vocabularies, phrases, the representation of inflections, and all other matter that may be of value in the study.

REPORT ON THE GEOLOGY OF THE HIGH PLATEAUS OF UTAH. With Atlas. By C. E. DUTTON, Captain of Ordnance, U. S. A. Washington: Government Printing-Office. Pp. 307.

THE surveys, of which this report gives an account, were conducted, in 1875, 1876, and 1877, in connection with the surveys of Major J. W. Powell, and under his direction. The Colorado plateaus, of which the district covered by the survey is a part, extend from southern Wyoming through western Colorado and eastern Utah far into New Mexico and Arizona, and have a general elevation of about seven thousand feet above the sea, but which varies from five thousand to twelve thousand feet. The high plateaus constitute one of the most important of the several groups into which the region is divided, and occupy a belt of country extending from a point about fifteen miles east of Mount Nebo in the Wahsatch Mountains for about one hundred and seventy-five miles to

the south-southwest, and having a breadth of from twenty-five to eighty miles, and a total area approaching nine thousand square miles. They are distinct, structurally and topographically, from the Wahsatch range, belong to another age, and are wholly different in their forms and geological relations. They are composed of early Tertiary and late Cretaceous formations, nearly or quite horizontal, and usually capped with lava formations of exceedingly complex arrangement. The region is for the most part destitute of vegetation and soil, and dissected by deep cañons. Consequently, its geology, as a whole, is plainly revealed, so that every fault, every flexure, the relations of successive unconformities, and all facts of structure are seen at once; but two sources of obscurity exist, in that some of the highest plateaus are covered with forests and vegetation, and that the extravasated rocks are aggregated in a more confused manner than the sedimentary beds, so that uncertainties and doubts still remain after the utmost labor and care in tracing them. The surface of the plateaus appears to have formed the bottom of a lake in Eocene times, and to have gradually risen to its present height by a movement which may still be going on. The drainage is by the tributaries of the Colorado, whose channels were formed in the lake-bottom before it was wholly dry, and have kept their course and level where they are, "in spite of faults, flexures, and swells, in spite of mountains and plateaus," the streams turning neither to the right nor to the left as these irregularities were encountered, but persistently cutting their way through the same old places, till the present magnificent cañons have been carved out. Another salient feature of the region is given by the extraordinarily extensive faults, the results of displacements which took place in relatively recent times. Some five or six of these great displacements are from twenty to a hundred miles long, and are of heights rising to a maximum of five thousand feet. One of them, the Eastern Kaibab fault, is the longest line of displacement of which the author has any knowledge; it has a length which can not fall much short of three hundred miles, and may be found to exceed that after its termini have been discovered, and a maximum height of seven thousand feet. The displacements do not belong wholly to any one period, but are of distinct though not widely separated ages. The erosions of the plateau do not appear to have been affected by the presence of ice during the glacial epoch, but the evidence is strongly in favor of the conclusion that the climate in this district was not glacial. "The ravines and valleys are conspicuously water-carved, and conspicuously *not* ice-carved." Yet evidences of the former existence of small local glaciers are found on the summits of the cliffs, not less than eight thousand five hundred to nine thousand feet high; and this is believed to emphasize the evidence of the absence of ice-action in the valleys and plateau flanks.

The region is one of extinct volcanism, the action of which, though small compared with that we know of some other regions, has been great compared with what is seen in most of the volcanic districts of Europe. The phenomena are of the most varied kinds, and relate to eruptions of which the oldest go back to the middle Eocene, while the latest "can not be as old as the Christian era," and "it is hard to believe that they are as old as the conquest of Mexico by Cortes." They are subjected to a careful study, especially with reference to the order of succession of the eruptions, and a comparison of the same with the arrangement proposed by Baron Richtofen. This study is followed by a discussion of the origin of volcanic eruptions, as illustrated by these phenomena. The photographic work not having been completed, has not been embodied in the present volume. The text is more especially devoted to the general geology, while many of the details are made more clear by heliotypic illustrations than they can be by mere textual descriptions. The atlas contains topographical, geological, and relief maps, and a sheet showing the arrangement of the faults and flexures.

THE POWER OF MOVEMENT IN PLANTS. By CHARLES DARWIN, LL. D., F. R. S., assisted by FRANCIS DARWIN. With Illustrations. New York: D. Appleton & Co. 1881. Pp. 592. Price, $2.00.

MR. DARWIN'S latest study of plant-life shows no abatement of his power of work or his habits of fresh and original observation. We have learned to expect from him at intervals, never much prolonged, the re-

sults of special research in some by-path or other subordinated to the main course of the biological system associated with his name; and it has been an unfailing source of interest to see the central ideas of the evolution and the continuity of life developed in detail through a series of special treatises, each wellnigh exhaustive of the materials available for its subject. It is in the department of plant-life that he has of late years devoted himself to working out the laws which govern the whole realm of vital phenomena. That these laws in their origin and ultimate operation are common to plant and animal alike has long formed a characteristic principle or axiom of his philosophy. In the experimental study needed for the elaboration of the vital processes and the making good the resulting generalizations, the kingdom of plant-life offers decided advantages beyond that of animals, if it were only that observations of this class are free from all possible taint of inhumanity. Mr. Darwin has in the quietude of his hothouse, and with a boundless variety of forms for selection, experimented upon the vital organism of plants, seconded by the untiring energy and patience of his son. Night and day seem to have come alike to the aid of this enthusiastic pair of naturalists. The electric light has served them on the failure of the sun's beams, and has in truth opened up of itself a wholly new field for observation as regards the agency of light upon the phenomena of life. To the vista of knowledge revealed by these experiments upon the elementary processes of life in movement, growth, nutrition, respiration, sensation, etc., imagination can set no bounds. It is impossible, Mr. Darwin remarks at the close of his record of these interesting experiments, not to be struck with the resemblance between the foregoing movements of plants and many of the actions performed unconsciously by the lower animals. This analogy has been made the subject of much interesting investigation by Sachs, Frank, and other leading biologists on the Continent, and we may expect that the highly original and elaborate experiments recorded in the volume before us will give fresh stimulus to this most important course of investigation, laying as they do a new and more solid basis for the comparative study of plant and animal life. Plants, of course, possess neither nerves nor a central nervous system, and there is consequently lacking in them that which gives its most distinctive character to animal life as a whole. Yet that sensitive impressions are present in plants, with the power of movement in obedience to the stimulus thereby imparted to the organism, may be held to be conclusively shown by facts such as those produced by Mr. Darwin. Most striking of all, he urges, as a point of resemblance, is the localization of their sensitiveness, and the transmission of an influence from the excited part to another, which consequently moves. May it not be inferred that in animals the nervous structures serve merely for the more perfect transmission of impressions and for the more complete intercommunication of parts? From the earliest sign of germination in plants—namely, the protrusion of the radicle from the seed-coats under the soil—there is manifest a sensitiveness to external influences, with a movement in response to the conditions of light or pressure, etc., which is not sharply to be distinguished from the rudimentary intelligence in animals. In the sensitive point or tip of the radicle, which we might compare with the antennæ in insects, there is to be seen an organic power equivalent, in a lesser degree, to the action of the brain in the lower animals:

> We believe that there is no structure in plants more wonderful, as far as its functions are concerned, than the tip of the radicle. If the tip be lightly pressed or burned or cut, it transmits an influence to the upper adjoining part, causing it to bend away from the affected side; and, what is more surprising, the tip can distinguish between a slightly harder and softer object, by which it is simultaneously pressed on opposite sides. If, however, the radicle is pressed by a similar object a little above the tip, the pressed part does not transmit any influence to the more distant parts, but bends abruptly toward the object. If the tip perceives the air to be moister on one side than on the other, it likewise transmits an influence to the upper adjoining part, which bends toward the source of moisture. When the tip is excited by light (though in the case of radicles this was ascertained in only a single instance) the adjoining part bends from the light; but when excited by gravitation the same part bends toward the center of gravity. In almost every case we can clearly perceive the final purpose or advantage of the several movements. Two, or perhaps more, of the exciting causes often act simultaneously on the tip, and one conquers the other, no doubt in accordance with its importance for the

life of the plant. The course pursued by the radicle in penetrating the ground must be determined by the tip; hence it has acquired such diverse kinds of sensitiveness. It is hardly an exaggeration to say that the tip of the radicle thus endowed, and having the power of directing the movements of the adjoining parts, acts like the brain of one of the lower animals; the brain being seated within the anterior end of the body, receiving impressions from the sense-organs, and directing the several movements.

In this suggestive passage, with which our authors bring their present course of investigations to a close, we see opened up a far-reaching prospect for the biological progress of the future. For the present it must suffice to have made good so much as our authors have been able to report from their patient study of the simpler and more easily observable vital phenomena.

A great part of Mr. Darwin's work is taken up with the details of experiments for measuring the quantity and direction of motion in plants, both under natural and artificial conditions. Direct observations have been made in numerous cases under the microscope, and in others use has been made of delicate apparatus of various kinds. Minute bits of card or tissue paper have been attached to the radicles, filaments, or terminals of stems, and tiny particles of metal or beads of shellac have been employed as weights to test the power of rigidity or of sensitiveness in the fibers of plants. Pins stuck in the soil around the stem have served to mark the conduct of the plant when impeded in its growth or its spontaneous habits of movement. The movements of the tenderest filaments or leaflets have been made to trace themselves in lines upon smoked glass. A series of diagrams has in this way been worked out, and set before the eye in numerous woodcuts, generally magnified two or three fold, showing the general law of circumnutation indefinitely modified by special conditions. The differences of movement in seedling and mature plants, in monocotyledons and dicotyledons, with the indications of certain movements having been acquired for a special purpose, are pursued through widely contrasted classes of plants. The circumnutating powers of young leaves are described in thirty-three genera belonging to twenty-five families, widely distributed among ordinary and gymnospermous dicotyledons, and among monocotyledons, together with many cryptogams. Here the seat of movement is generally seen to lie in the petiole, but sometimes both in the petiole and the blade, or in the blade alone. The movement is chiefly in a vertical plane; yet, as the ascending and descending lines never coincide, there is always some lateral movement, resulting in irregular ellipses, so that the motion becomes really one of circumnutation. It is interesting to mark the periodicity of leaf-movement, a gentle rise being observed in the evening and the early part of the night, with a sinking toward morning. In *Dionæa* and certain *graminiæ*, a strange jerking and oscillatory movement is to be seen under the microscope, curiously contrasted with the immobility of the tentacles of *Drosera rotundifolia*, which are yet sensitive enough to curl inward in twenty-three seconds so as to absorb a bit of raw meat. The distinction of epinastic and hyponastic growth—according as the growth takes place more rapidly in the upper or lower surface of an organ, causing it to bend downward or upward respectively—introduced by De Vries, has been illustrated in the case of a number of plants. To Frank is due the introduction of the useful terms of "heliotropism," for the tendency to turn to the light, with its correlative "apheliotropism," the opposite tendency, occasionally to be observed, "geotropism," for the bending toward the earth, and "apogeotropism," expressing motion in opposition to gravity or from the center of the earth. For the measurement of movements, sometimes excessively minute, various expedients were adopted. Dots were made from time to time upon sheets of glass placed vertically and horizontally near the plant, these dots being then copied on tracing-paper and joined by ruled lines, arrows being added to show the direction of the movement. The plants were exposed to varied conditions of light, sometimes being wholly protected, the light at other times being admitted from above or from either side. In addition to the sun's rays, the electric light was made the subject of experiment, with results comparable with those of Dr. Siemens. A valuable chapter is given to the sensitiveness of plants to light, with its transmitted effects. That growth in general is checked by light, which acts upon

plants much in the same manner as it does upon the nervous system in animals, is a statement which needs to be reconciled with the undoubted fact that the power of bending to the light is beneficial to plants, and may in all probability have been specially acquired under the action of natural selection. Experiments have abundantly shown that growth is exceptionally promoted by light continuously kept up, as in the polar summer, or when the absence of sunlight is compensated by the electric ray. Herein is, of course, involved the intricate problem of the sleep of plants, which is carried on through two chapters of the highest interest.—*Saturday Review.*

GUIDE TO THE STUDY OF POLITICAL ECONOMY. By DR. LUIGI COSSA. Translated from the second Italian edition. With a Preface by W. STANLEY JEVONS, F. R. S. London: Macmillan & Co. 1880. Pp. 237. Price, $1.25.

THIS is a work which no English student of economics can fail to find of the greatest value, in helping him to a knowledge of the extent and worth of the economic writings of foreign authors. Dr. Cossa is peculiarly fitted, by his wide acquaintance with economic literature and by his breadth of view, to make a competent and trustworthy guide, and the translation of his work into the chief European languages sufficiently attests its merit. The work comprehends a brief exposition of the scope, character, and method of the science, with an historical review of its position and doctrines in ancient and modern times, and a long list of the writings of economists of all countries, with indications of their worth. In the first chapter the science is defined and its demarkation from allied branches of knowledge pointed out. The division of the science and its relation to other sciences occupy the author in the next two chapters, the views of a number of leading economists being given. The chapter upon method contains a brief but excellent discussion of the questions involved in the controversy between what are known as the historical and philosophic schools, Dr. Cossa pointing out the error of main position of the former school, while admitting the value of much of the work accomplished by its members. A consideration of the importance of the science and an examination of some of the objections to it complete the more general part of the work, the remainder being devoted to the historical review. This includes a notice of the political economy of the ancients, of the middle ages, and of modern times, treating briefly in the latter period of that of the physiocrats, of Adam Smith and his successors, of the economists of the present century, and closing with a consideration of contemporary Italian economists. An index of the authors quoted in the text is placed at the close of the volume, the list containing over seven hundred names.

THE YOUNG FOLKS' CYCLOPÆDIA OF PERSONS AND PLACES. By JOHN D. CHAMPLIN, Jr., late Associate Editor of the "American Cyclopædia." With numerous Illustrations. New York: Henry Holt & Co. 1881. Pp. 936. Price, $3.50.

THIS work, including both real and fabulous persons and places, is intended, in connection with the "Young Folks' Cyclopædia of Common Things" by the same author, to cover the usual range of cyclopedic knowledge. The language is simple; technical terms where admitted are explained; the illustrations are selected to exclude those common in school-books, and preference is given to those showing restorations of classic scenes and famous buildings. The pronunciations are indicated approximately by plain English letters; and the size of countries and cities is made more plain by comparing them with States and towns at home. Most of the facts are brought down to 1880.

JAMES SMITHSON AND HIS BEQUEST, by WILLIAM J. RHEES; and THE SCIENTIFIC WRITINGS OF JAMES SMITHSON, edited by WILLIAM J. RHEES. Washington: Published by the Smithsonian Institution. 1879. Pp. 227.

THE preparation of a biography of the founder of the Smithsonian Institution has been delayed on account of the scantiness of the materials. Unusual exertions were made last year to collect the facts and incidents of the life of Mr. Smithson, but nothing new was elicited. The few facts which are known have been collected by Mr. Rhees as all the information likely to be obtained, and are presented for the first time as an authentic account of the man

who crowned a well-earned reputation for scientific attainments with his remarkable bequest for the increase and diffusion of knowledge among men. Three portraits of Mr. Smithson and a view of his tomb at Genoa lend attractions to the work.

The volume contains, of Smithson's scientific writings, twenty-seven papers, mostly on chemical subjects, which were published in the "Transactions of the Royal Society of London," and Thomson's "Annals of Philosophy," between 1791 and 1825, with reviews of the scientific character of the papers by Professor Walter R. Johnson and J. R. McD. Irby. Mr. Smithson left, in addition to these papers, several hundred manuscripts, scraps, and notes on many subjects, which were destroyed in the fire at the Smithsonian Building in 1865.

REPORT ON THE CULTURE OF THE SUGAR-BEET AND THE MANUFACTURE OF SUGAR THEREFROM IN FRANCE AND THE UNITED STATES. By WILLIAM MCMURTRIE, E. M., Ph. D., Superintendent of Agriculture in the United States Section, and Agent and Representative of the United States Department of Agriculture, at the Paris Exposition of 1878. Washington: Government Printing-Office. 1880. Pp. 294.

MR. MCMURTRIE took advantage of his visit to the Paris Exposition to secure full information concerning the methods of culture of the beet and manufacture of sugar followed in France, and the same is given here, with additional information from other countries in Europe. The conditions most favorable to the success of the beet-sugar enterprise appear to be a mean temperature of not more than 70° and a minimum average rainfall of above two inches during the summer months. Tables, with illustrative charts, are given, showing in what parts of the United States these conditions exist. Full detailed reports are added of the progress and present condition of the sugar-beet culture in the New England States, particularly in Maine. The machinery used in making the sugar is illustrated by descriptive cuts.

SANSKRIT AND ITS KINDRED LITERATURES. Studies in Comparative Mythology. By LAURA ELIZABETH POOR. Boston: Roberts Brothers. 1880. Pp. 468. Price, $2.

THE object of the author has been to interest people in the study of all literature on the new basis which has been laid by the sciences of comparative philology and comparative mythology; to show that literature is one and continuous; that the same leading ideas have arisen at epochs apparently far separated from each other; and that each nation, however isolated it may seem, is, in reality, a link in the great chain of development of the human mind. The most prominence is given to Sanskrit as the oldest and nearest to the foundation of the Aryan literatures, which is viewed in its Vedic and Buddhist aspects, and in the light of the greatest works in either branch. A notice of the ancient Persian literature and the Zendavesta follows, after which are chapters on Greek mythology, poetry, drama, philosophy, and history, Latin and Keltic, Scandinavian, Anglo-Saxon, and German literatures, mediæval hymns and ballads, the mythology of Slavonic literature, and the modern poetry of Europe.

HIGH SCHOOLS. By B. G. NORTHROP, Secretary of the Connecticut Board of Education. Syracuse, N. Y.: Davis, Bardeen & Co. Paper. Pp. 26. Price, 25 cents.

MR. NORTHROP in this pamphlet essays to answer the objections that have been urged during a few years past against the continuance of the public high schools. To the objection that they are an excrescence on our school system, aside from the design of its founders, he replies that they have been maintained in Massachusetts for a longer time and on a broader scale than in any other state of the world, the first law establishing them having been passed in 1647. He urges that the high school lifts up all the schools of lower grades by giving increased efficiency to them through its standard of admission, which presents a strong stimulus to studiousness and fidelity. It is true that only a small proportion of college students have received their preliminary training in the high schools, but it is claimed on the other side that the interest of a large proportion of the students in higher education was first excited in the high schools, and that they have gone out from them to the academies where they have received their special preparation. That the high schools have not a communistic tendency, as some assert, is proved by the fact that communism prevails

least where they are the most flourishing; they are not in the nature of a charity, as some seem to believe, but are an assertion of the right of the State to demand that its people should have the education necessary to its preservation and prosperity. Much of the opposition to high schools has arisen from mistakes that have been made in their management. They should not undertake to teach Latin and Greek, or other branches that the pupil may not have occasion or opportunity to apply or continue in after-life, but should aim rather to teach him how to study, and to inspire him with love of learning.

THE GEOLOGICAL AND NATURAL HISTORY OF MINNESOTA. The Eighth Annual Report, for the Year 1879. St. Paul: the Pioneer-Press Company. 1880. Pp. 183.

THE year's work of surveys was carried on chiefly in the northern part of the State, and resulted in the extension of the surveyed area in northeastern Minnesota, except as to some points on the Cascade River, as far west as the Poplar River, and over a considerable district west of that stream. Studies have also been made of the drift-covered counties in the central and western part of the State, with especial reference to their topography, glacial geology, and economic resources. Collections have been made of animals and plants on the shores of Lake Superior, and a partial catalogue of species of birds is given.

NINTH REPORT OF THE STATE ENTOMOLOGIST ON THE NOXIOUS AND BENEFICIAL INSECTS OF THE STATE OF ILLINOIS. Fourth Annual Report by CYRUS THOMAS, Ph. D. Springfield, Illinois: Weber & Co., State Printers. Pp. 142.

THE increasing demand for the State Entomological Reports is regarded as indicating that farmers and horticulturists are paying more attention to entomology than formerly, and attests the usefulness of the office of State Entomologist. The present report gives especial attention to the history of the European cabbage-worm; and, though the author considers it a diversion from his legitimate field, in answer to repeated requests furnishes information in reference to parasites infesting domestic animals.

ABRIDGMENT OF THE NAUTICAL ALMANAC FOR 1881. Philadelphia: Riggs & Brother. Pp. 150. Price, 25 cents.

BESIDES the hydrographic notices, the rules of the road at sea, and the catalogue of lighthouses, this abridgment contains an important paper on maritime meteorology, by Professor Thompson B. Maury. The paper embraces a synopsis of the nature and direction of the prevailing winds of the Atlantic coast and ocean, and of the laws that appear to govern the course of hurricanes; to which are added hints for handling ships in or near cyclones, by the observance of which shipmasters may be enabled to decide upon and pursue the course most likely to insure the safety of their vessels.

MR. HENRY GEORGE has in the press of D. Appleton & Co., and will shortly publish, a new book, entitled "The Irish Land Question: What it involves, and how alone it can be settled."

PUBLICATIONS RECEIVED.

The Causes which produce the Great Prevailing Winds and Ocean-Currents, and their Effects on Climate. By C. A. M. Taber. Boston: David Clapp & Son, printers. 1881. Pp. 54.

Report on the Marine Isopoda of New England and Adjacent Waters. By Oscar Harger. Pp. 166, with Thirteen Plates. From the Report of the United States Commissioner of Fish and Fisheries. Part VI for 1878.

The Development of Osseous Callus in Fractures of the Bones of Man and Animals. By Henry O. Marcy, M. D. Philadelphia: Collins's printing-house. 1880. Pp. 20.

Report of the Analysis of the Ohio River Water. By C. R. Stuntz, M. D. Cincinnati: Robert Clarke & Co. 1881. Pp. 29.

Dr. Edward Jenner's Discovery of Vaccination. By E. L. B. Godfrey, M. D. Philadelphia: Hoeflich & Senseman, printers. Pp. 16.

Higher Education of Medical Men. By F. D. Lente, M. D. New York: C. L. Birmingham & Co. 1881. Pp. 16.

A Syllabus of Anglo-Saxon Literature. By J. M. Hart, University of Cincinnati. Cincinnati: Robert Clarke & Co. 1881. Pp. 69.

The Strong Galvanic Current in the Treatment of Sciatica. By V. P. Gibney, M. D. Philadelphia: Collins, printer. 1880. Pp. 11.

Second Biennial Report of the Superintendent of Public Instruction of the State of Colorado. Denver, Colorado: Tribune Publishing Co. 1881. Pp. 133.

Nasal Catarrh and Ozæna. By George Pyburn, M. D. Sacramento, California: Day & Joy, printers. 1881. Pp. 16.

Clinical Anatomy of the Lower Extremity. By W. W. Keen, M. D., of Philadelphia. Illustrated. Brooklyn, New York. 1881. Pp. 20.

The Structure and Affinities of Euphoberia: a Genus of Carboniferous Myriapoda. By Samuel H. Scudder. Reprint from the "American Journal of Science." Pp. 5.

Tidal Theory of the Forms of Comets. By George W. Coakley. Salem, Massachusetts. 1880. Pp. 18.

"Papilio." Organ of the New York Entomological Club. Vol. I, No. 1. New York. January, 1881. Pp. 12. Subscription, $2 per annum (ten numbers).

Third Annual Announcement of the Normal and Scientific School, Morris, Illinois. Morris. 1880. Pp. 22.

On the Constitution of the Naphthalines and their Derivatives. By M. M. F. Reverdin and E. Notting. Translated from the German by M. Benjamin, Ph. B., and T. Tonnele, Ph. B. Pp. 8.

Indications of Character in the Head and Face. By H. S. Drayton, A. M. Illustrated. New York: Fowler & Wells. 1881. Pp. 48. Price, 15 cents.

Pueblo Pottery. By F. W. Putnam. From the "American Art Review" for February, 1881. Illustrated. Pp 4.

The Spirit of Education. By M. l'Abbé Amable Béesau. Translated by Mrs. E. M. McCarthy. Syracuse, New York: C. W. Bardeen. 1881. Pp. 325. $1.25.

Reminiscences of Dr. Spurzheim and George Combe. By Nahum Capen, LL. D. New York: Fowler & Wells. 1881. Pp. 262. $1.50.

Drugs that enslave. The Opium, Morphine, Chloral, and Hashisch Habits. By H. H. Kane, M. D. Philadelphia: Presley Blakiston. 1881. Pp. 204. $1.50.

First German Book. After the Natural or Pestalozzian Method. By James H. Worman, A. M. New York and Chicago: A. S. Barnes & Co. Pp. 63. 35 cents, post-paid.

The Baldwin Locomotive Works. Illustrated. Philadelphia: J. B. Lippincott & Co. 1881. Pp. 153. $5.

The Human Body: An Account of its Structure and Activities, and the Conditions of its Healthy Working. By H. Newell Marten, D. Sc., etc. Illustrated. New York: Henry Holt & Co. 1881. Pp. 655. $1.75.

POPULAR MISCELLANY.

An Epidemic of Hystero-Demonomania.—An Italian physician, Dr. Franzolini, has published an account of an hystero-demoniac epidemic which prevailed in the rural district of Verzeguis, province of Friuli, Italy, in 1878, and which he and Dr. Chiap were commissioned by the Prefect of Udine to examine. The commune contains about eighteen hundred inhabitants, of whom, at the time the inquest was made, sixty-two women and eleven men in two of its four subdivisions were sick, the majority of them with nervous affections of different degrees of intensity, and generally of the hysteric form without convulsions or delirium. The people of the commune were of inferior intellectual capacity and development, enjoyed little communication with the world, had been in the habit of intermarrying with each other and often with relatives of the third and fourth degrees, and were uneducated, and greatly under the influence of the priests. In November, 1877, previous to the appearance of the disease, the Jesuits had conducted a mission in the commune, with exercises and services occupying nearly all the time for several days. A general, intense religious excitement was thus produced. Two months afterward, Margherita Vidusson, a delicate girl twenty-six years old, who had already had hysteric symptoms, supposed to arise from simple nervous disease, for eight years, was attacked with convulsive fits, accompanied with lamentations and cries, which were repeated with varying frequency, intensity, and duration. Sometimes she would have ten or twelve short and quite distinct attacks in a day; at other times the attacks would continue through the day and night, with alternative remissions and exacerbations. The most intense attacks corresponded with the catamenial period. Physical remedies were employed at first against the disease, but the girl was at last believed to be supernaturally possessed, and the priests were called in to practice their exorcisms upon her. The affection then seemed to become more violent and its manifestations to assume a more dramatic form after each priestly visitation. A second person was attacked in a similar manner in July, 1878, then a third and a fourth. A commission of priests was sent to examine into the cases, a solemn mass was held, and other exercises were instituted, after which the malady took a new start and became epidemic. Drs. Franzolini and Chiap were appointed at this time to investigate the character of the disease, and suggest measures for arresting it. They found eighteen persons suffering from violent attacks, all of whom were of marriageable ages, from seventeen to twenty-six years old; one was forty-five, another fifty-five, and a third sixty-three. The symptoms of hysteria in its most simple form, without convulsions or mental aberration, had been observed in all of them for from one or two to five or ten years before the development of the morbid form. In some of them the symptoms of the former form ceased on the appearance of those of the latter. At a given moment in the course of the simple form, new symptoms

would appear which might have passed at first for a graver form of the preëxisting symptoms. From a stage marked by convulsive cries, the patients would fall into a kind of swoon in which consciousness failed and speech became more or less difficult and finally impossible; or the attack would be continued with a kind of mental exaltation in which, without being conscious of it, the patients would indulge in conversations having all the characteristics of the delirium of mania, in some cases of that of demonomania. They would speak in the third person and as if they were men, clearly giving it to be understood that it was not they that spoke, but some other spiritual person—a demon, who used their organs to express what they seemed to say and to execute what they seemed to do. When asked who they were, they would not give their own name, but some strange man's name, which was an epithet rather than a name, and belonged to the demon that possessed them, adding that he had lived in their bodies for months or years, and before that had lived in the body of a person in some other country. Some, in their fits, declared themselves to be witches or diviners, and pretended to answer all sorts of questions and to predict events; the more they were excited by the curiosity or credulity of those who inquired of them, the more ardent they seemed to be to predict and lie with impudence. Blasphemies and imprecations characterized all the attacks, but no appearance of amorousness was shown. Sometimes the patients spoke in Italian instead of in their native Friulian dialect, and witnesses who can hardly be depended upon asserted that some of them spoke in French and Latin. After the attacks some remained sleepy and exhausted, others recovered their natural physical energy and resumed their ordinary occupations, as if they were in good health. At the same time, a certain mental exaltation remained, with the latter class especially, and was revealed by a loquacity, an impertinence, and a boldness in strong contrast with the ordinary excessive timidity of mountain-girls in the presence of strangers. They would laugh without cause and without restraint when questioned respecting their affliction, and protested that they recollected nothing of what they had done in their fits, seeming to believe that they were not sick, but possessed. The attacks were provoked in the majority of cases by the sound of the church-bells: some pretended that the sound operated as a natural exorcism upon the evil spirits of the air; others asserted that the consecration of the host, which was announced by ringing the bells, was the real determining cause of their attacks. The malady was generally aggravated after religious ceremonies, such as masses and pilgrimages; nevertheless, with some, the contact of a sacred relic applied by a priest to the neck or breast was enough immediately to arrest the attack. The means employed to put a stop to the epidemic embraced the instruction of the population against their superstitious beliefs, the discouragement of the exciting religious exercises, exorcisms, and pilgrimages, the isolation of the sick and their dispersion into neighboring districts, so as to prevent them from making a spectacle of themselves, and the institution of a regular medical visitation. The epidemic character of the disease was arrested, and the attacks suffered by the patients became less frequent and violent; but some of the number who were sent home from the hospital at Udine became worse again after their return. A more rigorous application of remedial measures was urged, the operation of which Dr. Franzolini promises to describe in another report.

The Strawberry-Leaf Beetle.—A new destructive insect has been described by Professor A. J. Cook, of Illinois, as preying on the leaves of the strawberry-plant. It is described as the *Paria aterrima*, or strawberry-leaf beetle, and belongs to the family *Chrysomelidæ*, the same to which the Colorado potato-beetle and the grape-vine and cabbage flea-beetles belong. It is about an eighth of an inch long, with yellowish head, antennæ, legs, and wing-cases, brown thorax, clouded with black at the center, and body black on the under side. The yellowish wing-cases have also two black spots, of which the hinder one is the larger. The species is at least two-brooded, appearing first in March, April, and May, and again in July, and may possibly be still more prolific. The larva is white, with

a yellowish head and brown jaws, eleven segments back of the head, the breathing mouths showing plainly along the side of the body, and is ·22 of an inch long. The insects are voracious feeders, and numerous enough to strip the strawberry-plants completely of leaves in the spring and after harvest. The larvæ eat the young roots. Both the larvæ and the pupæ harbor in the earth about the roots of the plants.

Singular Powers in Birds.—Mr. A. D. Bartlett, of the London Zoölogical Society's gardens, has called attention to the singular fact, heretofore unnoticed, that certain birds have the power of ejecting the inner linings as well as the contents of their stomachs. He first noticed this peculiarity when a wrinkled hornbill (*Buceros corrugatus*) in the gardens was observed to have thrown up a closed bag resembling a fig, which seemed to be the inner lining of the gizzard, being "somewhat tough, elastic, and gelatinous," and contained plums or grapes well packed together. He submitted the ejection to Dr. Murie, who regarded it as a result of disease, and expressed surprise that the bird should have lived and been able to feed after having made it. Another perfect specimen of the same kind was obtained a few days afterward and preserved. Others were noticed, all from the same bird, but they were destroyed by other birds in the same cage before they could be saved. Mr. Bartlett rejects the view that the ejection is a sign of disease, and is satisfied that it is a natural secretion provided for the bird during the breeding-season, and is the means by which the male hornbill supplies the female bird during the time he keeps her imprisoned, while she is sitting on her eggs. His opinion is supported by the observations of travelers on the habits of hornbills. The Rev. J. Mason says that, in Burmah, the male bird shuts the female in her nest in a hollow of a tree by plastering up the opening with mud, leaving only a place through which she can put her head, and guards her there; while, to compensate her for the loss of her freedom, he "is ever on the alert to gratify his dainty mistress, who compels him to bring all her viands unbroken, for if a fig or any fruit is injured she will not touch it." Mr. Wallace also has observed that the entrance to the nest of this bird is stopped up with mud and gummy substances. Dr. Livingstone states that when in Kolobeng, South Africa, his attention was directed to the nest of a hornbill, and he, looking, "saw a slit only, about half an inch wide, and three or four inches long, in a slight hollow of the tree." The natives gave an account of the imprisonment of the female bird similar to that related by Mr. Mason, and added that the male continued to feed her and her young family till the young were fully fledged, or for a period of two or three months. "The prisoner," Dr. Livingstone adds, "generally becomes quite fat, and is esteemed a very dainty morsel by the natives, while the poor slave of a husband gets so lean that on the sudden lowering of the temperature, which sometimes happens after a fall of rain, he is benumbed, falls down, and dies." Such exhaustion would result naturally from the draft of repeated ejections upon the vital forces. It is well known that parrots, pigeons, and other birds, reproduce their partially digested food during the pairing and breeding season. The male hornbill has the same habit, and a concave hornbill in the gardens "will frequently throw up grapes, and, holding them in the point of the bill, will throw them into the mouth of the keeper if he is not on the alert to prevent or avoid this distinguished mark of its kindness." The edible swallow's nest is made of a secretion from the glands of a kind of swift; and many other birds are known to cast up secretions having individual peculiarities. Mr. Bartlett, continuing his observations, has found two other birds—the darter (*Plotus anhinga*) and the Brazilian cormorant (*Phalacrocorax Brazilianus*)—which throw up the inner linings of their stomachs, as do the hornbills.

Mode of Termination of Nerves in Muscle.—M. Foettinger has recently published a memoir on the mode in which nerves terminate in muscles. The muscles of insects were selected for observation in preference to those of other animals, because the details of their structure are more easily recognizable under the microscope than those of other groups of the animal king-

dom. The insects were placed in strong alcohol for some days, and the isolated fibers of the legs or trunk were examined with various powers. Each fiber or primitive fasciculus presents several nerve-endings, which are attached to the muscular fiber apparently without any definite rule as to their position or distribution. The muscular elements to which they are fixed are usually conical in form, a nerve running to the summit of each cone. The cone itself is composed of granular matter, with nuclei interspersed through it; and the granular matter is apparently sometimes obscurely segmented into portions surrounding each nucleus. The nerve-endings, or terminal plaques, as M. Foettinger calls them, are situated on the surface of the fiber, and their free surface is covered with a thin, structureless, transparent membrane, continuous with the sarcolemma of the muscular fiber on the one hand and the sheath of Schwann investing the nerve-fiber on the other. In insects contraction always begins in the muscular fiber at the plane of the cones, and at those points exclusively.

An Improved Smokeless Grate.—Dr. C. W. Siemens has recently proposed to remedy the smoke-nuisance, where it is due to the burning of bituminous coal in private houses, in a very simple way. Instead of burning such fuel in its crude state, in which the volatile and solid constituents are combined, he makes use of them after they have been industrially separated into the forms of coal-gas and coke. In these forms perfect combustion of both constituents is possible, and a smokeless and cleanly fire is produced at but little greater cost than with coal, and considerably less than gas alone. In order to burn the gas and coke together, Dr. Siemens has devised a simple and inexpensive modification of the ordinary grate, that can readily be made in any existing one. The construction consists in covering the bottom bars of a grate with a metal plate, which is bent to extend up the back, and in placing a gas-pipe along the lower front edge. This pipe is perforated on its upper side, the holes being a little inside of the middle line, so that the gas-flames incline slightly inward. The grate is filled with coke, which becomes incandescent upon its surface from the flame passing over it, and, as the interior of the mass is not heated, the maximum radiation from a given amount of fuel consumed is obtained. The coke has, of course, to be from time to time replenished, and the ashes removed, but in neither of these operations is there the trouble, or the dust and dirt, incident to the ordinary method of burning coal. Air is allowed to enter only in front, so that the mass of coke is protected from cooling drafts by the layer of hot gases. The heat of the bottom bars of the grate may be made to warm the air supplied to the gas, by a bent plate placed below, so as to form a chamber through which this air has to pass. Compared with the various forms of gas-grate, Dr. Siemens estimates that the cost for fuel is largely in favor of this. A thousand cubic feet of ordinary illuminating gas develops by its combustion 748,000 heat-units, and costs in London eighty-seven cents, while, to produce the same amount of heat by coke, fifty-six pounds are requisite, the cost of which is but eleven cents. Experiment has shown that, to heat a large room, eight feet of gas burned in this grate are sufficient, while fifty to seventy feet, Dr. Siemens states, are needed in a grate using gas only. Such grates could go into use very largely without any change in the present gas plant, as gas companies produce both the gas and the coke in about the proportions used, and this Dr. Siemens regards as an additional point in their favor.

Elevator Pneumonia.—The pulmonary diseases to which men employed in elevators are subject are described in an article by Dr. Thomas F. Rochester, published in the "Buffalo Medical and Surgical Journal." These men, who are generally Irish, of a nationality subject to affections of the lungs, work in gangs, shoveling in a close atmosphere which is teeming with dirt and dust and bearded particles of grain, often for thirty-six hours—sometimes, they assert (although the employers deny it), for six or seven days and nights at a time. They are liable to contract a disease which is known in the hospitals as *elevator pneumonia*. A new man, soon after he begins to work in the elevator, experiences catarrhal, nasal, and throat irritation; and, while he may

labor through a whole season with nothing more than this, he is liable to develop a subacute bronchitis, and occasionally a more dangerous affection. The morbific effects increase in the second and third years, and the shoveler will at last probably have to go to the hospital with a peculiar pulmonary disease, which may be of every grade and usually affects both lungs. The attack fixes him in the ward for at least three months, after which he may wholly recover if he goes into a new business, but, if he returns to his shoveling, he will soon fall a victim to lung-disease. A very few men continue to work in the elevators till they become old; and it appears that those who begin it at thirty-five or forty years of age bear it better than those who begin at twenty. Dr. Rochester considers a regulation and limitation of the hours of continuous labor, the sanitary regulation of lodging and boarding houses, and restriction in the use of ardent spirits, essential parts of any measures for checking this disease.

The Green Color of Oysters.—The fact that the green color of some oysters is caused by a variety of navicula, which is called *Navicula ostrearia*, is illustrated and established by experiments which have been recently made by M. Puységur, at Sissâble. A quantity of the green slime scraped from the edges of the "clears" was put, after the mud had been allowed to settle, into soup-plates. Perfectly white oysters, which had never been in the "clears," and the shells of which had previously been washed and brushed clean, were then put into the fluid. Other precisely similar oysters were put into plates of ordinary sea-water. In twenty-six hours after the beginning of the experiment, the oysters charged with diatoms had all acquired a marked greenish hue, while the other oysters remained unaltered. The experiment was repeated several times, with identical results; and the green color in the oysters was found to be more decided in proportion as the water was more highly charged with diatoms. The greenness disappeared on leaving the oyster for a few days in ordinary sea-water, to appear again when it was put in fresh water containing the navicula. It appears that the diatoms are drawn into the stomach of the oyster with the currents which it induces, and there part with their nutritive constituents. The chlorophyl is digested, and imparts its color to the blood, whence it happens that the most vesicular parts of the structure, as the bronchiæ, are most highly colored. The fact of the absorption of the diatoms was proved by the examination of the digestive tubes of the oysters experimented upon. Their stomachs, intestines, and exuviæ were strewed with carapaces of naviculæ.

Deep-Sea Explorations off the Coast of France.—A commission appointed by the Minister of Public Instruction in France has just accomplished an exploration of the depths of the Gulf of Gascony, and of a great submarine valley which lies parallel to the coast of Spain. The commission was composed of MM. Milne-Edwards, father and son, and several other naturalists, and Mr. Gwyn-Jeffreys and the Rev. Mr. Norman, of England. The expedition was completely successful, having collected at least five hundred species, nearly all of which are new to the fauna of the Gulf of Gascony, and some of which are new to science. Previous to this expedition, Messrs. Gwyn-Jeffreys and Norman had explored the fosse, or ditch, of Cape Breton, a curious submarine cavity in the sea-bottom of the department of the Landes, in which a connection was traced between the fauna of the Mediterranean Sea and of that part of the Gulf of Gascony.

M. Delaunay's Theory of Earthquakes.—M. J. Delaunay has proposed a theory that earthquakes, as well as many meteorological phenomena, are produced by the passage of the planets through the masses of meteors. The more severe seismic tempests, he believes, are caused by the passage of the larger planets through the cosmic groups, particularly through those in longitudes 135° and 265°, which appear to give rise to the August and November meteors. The passages of Venus, the Earth, and Mars through the groups seem to occasion only earthquakes of a secondary order; but each of these planets produces on its passage an increase of shocks in the months of August and November. The most violent and long-

est-continued convulsions, M. Delaunay suggests, take place when two large planets pass by the cosmic groups at the same time. Of this character were the earthquakes of 1755, 1783, 1829, and 1841. Accepting these principles as the laws regulating the occurrence of earthquakes, and admitting that certain of the cosmic groups may have a slow oscillatory motion around a mean position, it is not difficult to predict when earthquakes may be looked for. M. Delaunay ventures to predict the dates at which the earthquakes to occur between this time and 1920 will, according to his theory, be due. The most important earthquake periods will probably occur in the years and groups of years 1886, 1890–'91, 1898, 1900–'01, 1912–'13, 1914, 1919–'20. The next seismic tempest may be expected to follow the passage of Jupiter through the zone of the August meteors in 1883.

Do Stenches cause Disease?—The people of Paris were frequently annoyed during the last summer by the presence of mephitic odors in the atmosphere. A commission, appointed to discover the origin of the smells, traced them to certain establishments in the neighborhood where refuse matter is manufactured into fertilizers. M. Bouchardat, of the medical faculty of Paris, has examined the question of the effect of these emanations upon health, and has concluded that they are innocent. He does not believe that they convey with them the germs of disease, and finds that the gases of which they are composed do not load the air enough to produce a perceptible poisoning. Moreover, no injury to health has been traced to them. Assuming that contagious diseases should manifest themselves within eight or ten days after the germs have been planted, the weekly health bulletins of the year have been examined to learn if any increase of mortality followed the prevalence of the unpleasant odors. No such increase has been detected, but the mortality seems rather to have fallen off.

Mr. Thomson's Journey in Eastern Africa.—Mr. Keith Johnston was dispatched by the London Geographical Society, in 1878, with an exploring expedition to East Africa, charged with examining the country in the neighborhood of Lakes Tanganyika and Nyassa. Mr. Johnston died at Behobeho, just at the borders of the objective region of the expedition, on the 23d of June, 1879, and the whole responsibility of the undertaking fell upon Mr. Joseph Thomson, his geologist and general assistant, a young man twenty-two years of age, to whom this was almost the first serious experience in life. Mr. Thomson gave a most interesting account of the expedition, which was attended by unexampled success, at a meeting of the Society on the 8th of November last. His story is enlivened with accounts of different tribes of the most diversified characters and degrees of civilization, living by the side of one another. Leaving Behobeho on the 2d of July, the expedition went toward the west, into the country of the Wakhutu, passing through the valley of the Mgeta, where perennial showers precipitated from the high mountain-range on the right, which forms the ridge of the great central plateau of the continent, stimulate a tropical vegetation to grow and rot in marshy tracts. Under the influence of such an enervating and malarious climate, the Wakhutu are one of the most miserable and apathetic races to be found in Africa, and presented a disgusting sight to the traveler as they gathered around him in crowds, "sitting with their miserable, withered bodies doubled up, and idiotic, lack-luster gaze." Their neighbors, the Mahenge, a hitherto unheard-of tribe, living between the Ruaha and Uranga Rivers, were brought several years ago in contact with a migration of Zooloos, and have adopted the arms, dress, and manners of those people, although in other respects having no affinity with them. To the Wakhutu the Mahenge are a warlike and dreaded tribe; to the English traveler, "they were a set of most arrant cowards, a mean, sneaking, lying race, unworthy of the name of men." Ten days were occupied in crossing the mountain-ranges that bound the central plateau—a charming journey, with diversified scenery and luxuriant vegetation—after which the party entered upon a bleak, moorland country four or five thousand feet high, unrelieved by hill or dale or forest-tree. The scanty population of this barren district of Uhehe are settled in villages at very wide

intervals; "the people are a fine-looking race of gentlemen savages, who dress indifferently in nothing, or roll themselves into a winding-sheet of twelve yards of cotton." They treated their visitors courteously, "and always took indirect means of telling us anything unpleasant." Another plateau, from six to nine thousand feet high, extends around the north and east sides of Lake Nyassa, half-way to Lake Tanganyika and around Lake Hikwa, or Leopold, and is inhabited by three tribes in the lowest physical and mental condition, with whom it was almost impossible to communicate, as they seemed to be devoid of abstract ideas, and shut out from all knowledge and communication with the outside world. A short distance beyond the northwest corner of the beautiful Lake Nyassa, the expedition came to Makula's country, where the life and manners appeared of charming Arcadian simplicity. "The clean and ornamental villages would have adorned the neighborhood of any nobleman's park, and the richness of the soil was quite unrivaled"; and Mr. Thomson left, as he left no other place, with regret, a country which he had entered with apprehension. Thence the expedition passed through the country of the bold, rude, exceedingly inhospitable Wanyika; through Itawa, where Mr. Thomson was taken prisoner, and escaped by laughing at the excited warriors and being thought uncanny; and through other not very remarkable districts, to the "noble river Lukuga" and Lake Tanganyika. The Lukuga winds through a charming valley, with beautiful wooded hills rising on each side from its borders, adorned with forest clumps and open glades, where antelopes and buffaloes grazed in abundance. The river moved along in an exceedingly rapid current, full of cataracts, along which it roared and surged, making any attempt at navigation a matter of impossibility. Mr. Thomson would have followed it, but his men refused to go farther, and he turned back. He passed three weeks with the Warua, a very fine-looking race of men, living in the plain between the Lukuga and the Lualaba. They "are possessed of well-made figures, which the women adorn most artistically with tattooing. They wear a kilt made of the fibers of the Mwale palm, and dress their hair in the most elaborate fashion, the operation requiring two days' hard work. They are exceedingly ingenious in their carvings, and in every respect they are neat in their appearance and cleanly in their habits, but there all praise ends." They are arrant scoundrels and thieves, and one is not sure of his life among them for a moment. The feature of the return journey to Zanzibar most worthy of remark was the sight—the first to Europeans—from the highlands of Fipa, of the curious Lake Rukwa, Likwa, or Hikwa, to which Mr. Thomson took the liberty of giving a fourth name, Leopold. It is situated about four thousand feet above the sea, is surrounded by precipitous mountains about as much higher, and has no visible outlet. The people of the country are agriculturists, who do not join either in war or the chase; their chief is a king with absolute power, who lives on native beer, and is prevented by custom from wearing anything but a simple loin-cloth. Mr. Thomson reached Zanzibar in the spring of 1880. During his journey of a year in this most difficult country, he lost only one of the one hundred and fifty men with whom he started; and though often placed in critical positions, he never once had to fire a gun for either offensive or defensive purposes.

Artificial Production of Minerals.—M. Friedel gave an extended account, in a recent lecture at the Faculty of Medicine, Paris, of what has been accomplished in the artificial formation of minerals. The condition necessary to be fulfilled in this manufacture is that of obtaining crystalline products as nearly as possible identical in composition and appearance with the minerals to be reproduced. Generally experimenters have had to be satisfied with microscopic crystals; accepting these as sufficient, numbers of them have succeeded. Some have tried to imitate the processes of nature; others have reached their end by independent processes. M. de Senarmont, considering that the minerals in veins had been deposited from water charged with their constituents and flowing through the fissures of the rocks, with carbonic acid, sulphuretted hydrogen, and the alkaline sulphurets as solvents, and under suitable

conditions of temperature and pressure, obtained the sulphurets, oxides, and metallic salts he sought, with the bed-rock that held them. M. Daubrée has reproduced cassiterite, and several of the minerals that are found with it, by subjecting water and the right oxides to the action of chloric and fluoric vapors. MM. Fouqué and Michel Lévy, also following the indications of geological observation, have obtained the minerals of volcanic rocks in crystals, not only as isolated minerals, but also with the associations under which they form real rocks, resembling the natural rocks so closely as to deceive. Other processes have been employed, varying in their nature and operation according to the minerals which it was desired to produce, or the substances from which their production was sought. The number of minerals obtained by the different processes is so great that the mere enumeration of them all would be tedious. The most obvious and simple process is that of fusion. Some substances, among them the silicates, tend, when they cool from a liquid condition, to form amorphous glasses. Many of these, it has been found, will crystallize when heated again nearly up to the melting-point. By this process of sub-fusion several of the feldspars, oxide of iron, spinel, garnet, and other minerals have been obtained. When the substance does not melt readily, or is liable to decompose before melting, the process is aided by heating it with some suitable solvent. Thus have been obtained apatite, wolfram, tungstate of lead, pyrites, boracite, and other minerals. A considerable number of minerals may be crystallized from solutions in water of different temperatures. A curious feature of this process is that it operates sometimes to render a hydrate anhydrous. At other times the water may serve as a base to remove a portion of acid. It has been noticed also in this process that the crystals may be made larger by exposing them to repeated variations of temperature. Some minerals have been obtained from volatile solvents by vaporizing the solvents, when the minerals would be precipitated. Another process is by the action of two substances upon each other with or without the addition of electrical excitement, as when the oxide of copper is produced by the action of the solution of sulphate of copper and galena; another is by the reaction of vapors and gases on other bodies of similar nature or on solids—a process in which chlorine and the members of its group may play an important part.

M. Faye's Theory of the Solar System.—M. Faye, having pointed out in a former paper certain particulars in which the nebular hypothesis of Laplace fails to account for the movements of the planets, has published a second paper propounding a theory by which the retrograde movements of a part of the planets may be reconciled with the direct motions of the other planets, as results of the same laws. The theory of Laplace presupposes the existence of an immense degree of heat expanding the mass of the sun and its atmosphere to the extreme limits of the solar system, and a contraction by cooling, in the course of which planetary rings were thrown off by an excess of centrifugal force. M. Faye objects to the hypothesis of great heat as one of which there is no evidence; moreover, if the heat had existed and contraction had taken place by cooling, the outer atmosphere of the sun would have participated in the cooling and contraction so fully that it would have adhered to the mass, and no rings would have been thrown off. The new theory which he proposes in the stead of that of Laplace is based on the observation of the nebulæ, bodies which astronomers have often regarded as the points of departure for evolutions very different from those pictured by Laplace for evolutions tending to formations of the most varied character, as simple, double, triple, and quadruple suns, and globular aggregations of minute suns numbered by thousands. Would it not be natural, he asks, to accept the suggestion of these facts, the more so since our system belongs to the most common type—that of a nebula at first vague, then undergoing a central condensation, absorbing itself gradually and regularly into a nebulous star and finally into a solitary sun? Under this view, heat would no longer have to be invoked arbitrarily as an external agent; we would, on the other hand, see it gradually developed in certain points of the nebula, as the proper result of the energy

of every great dissemination of matter where the different members of the mass exercise a mutual attraction upon each other at a distance. M. Faye admits that in the transformation of the nebula rotatory movements would take place, and that trains of matter analogous to the rings of Saturn might be formed, and might break and give rise to planets. These formations, he believes, could be divided, according to their relations to the gravitation of the mass, between two zones, in the outer one of which the revolutions would, by the regular operation of the laws of gravity, be retrograde, while in the inner zone they would, under the same laws, be direct. This is shown to be possible by the following considerations: The density in the original nebula increases regularly from the periphery to the center, as appears actually in several nebulæ with which we are acquainted. It has been shown by calculation that the force of weight in a mass thus constituted increases, as we depart from the surface, in the inverse ratio of a power of the distance from the center. This progression, however, soon reaches a maximum, after which the weight is proportional simply to the distance itself, till at the center it is nothing. If we suppose planetary rings to be separated from a nebula of this nature, we may see that those separating from the external region will be of such a character that the motion of their outer circumference will be more rapid than that of their inner circumference, so that, when it is reduced to a globe turning upon itself, the globe will move in a retrograde direction. In the rings found in the second or inner region, on the other hand, the relative rapidity of the motion of the greater and lesser diameters will be reversed, and the rotation of the resultant globe will necessarily be direct.

Infertility in France.—The population of France has increased very slowly for several years. Among nineteen principal states of Europe, France stands the lowest in the rate of growth, having shown an annual increase of only 3·16 per thousand inhabitants from 1861 to 1869, while such countries as England, Norway, Scotland, and Russia, show an increase of from 12·94 to 13·85 per thousand. The rate of increase has fallen from six per thousand in 1770–'85, and has never since risen to that figure. The smallness of the excess of births over deaths, which is measured by the rate of increase, is due solely to the paucity of births; for the mortality has at no time been excessive, and has diminished steadily in the face of wars and epidemics, except during the German war, since the beginning of the century. It is not accompanied by a diminution in the number of marriages, for the proportion of marriages has not undergone any material variation during the century, and was higher in the sixth decade than in the first. Moreover, France outranks in the proportion of marriages to the whole population, and of marriages to the marriageable population, some of the states which greatly exceed it in the rate of increase of population. M. A. Legoyt has investigated the subject, and assigns the infertility thus shown to various moral, political, economical, and physiological causes. The decay of religious beliefs is a cause, the influence of which is shown in the tolerance given to the voluntary limitation of fertility, which is opposed by every religious system, and the increase of illegitimate unions, abortions, still-born, and infanticides. The unusually large proportion of persons who are just well enough off to be carefully provident is economically unfavorable to fertility. The popular opinion that poverty and children go together seems to be confirmed in France, where the poorer departments are the more fruitful ones. Other economical influences are the tendency of population to cities, the increasing expenses of living, and the system of dividing the paternal estate among all the children, which offers a standing temptation to the parent to have only a few children, so that each shall have as large a share as possible. The destruction caused by war operates powerfully to cut down the population. It is worse than pestilence, for it takes away the best and most vigorous. France has suffered much by wars during the last century, and has lost heavily at several periods, most notably during the two years of the German war, when the deaths considerably exceeded the births. The statistics of the recruiting officers show, however, that the vigor of the race has not

diminished, and that the mean length of life has been prolonged since 1815. Men and women marry at a later age than formerly, diminishing by several years the time during which they can have children, and, consequently, the number of children they can have. The host of women who are employed as nurses must suspend child-bearing while they are so employed. Young men are withdrawn from the possibility of marriage during their most vigorous age by the long period of military service; marriage itself is discouraged by the complicated and expensive processes the parties have to go through; and increasing alcoholism contracts the reproductive powers of both sexes.

Statistics of Suicide.—Professor Morselli, of Milan, in his "Étude de Statistique Morale" ("Study of Moral Statistics"), gives an analysis of the statistics of suicides in the countries of Europe, compiled from official reports, which reveals the important facts that the number of suicides is increasing, with only a few exceptions, in all European countries, and that it increases more rapidly than the population. The facts are set forth in a table showing the number of suicides in the several countries, in each of the seven periods of five years, from 1841–'45 to 1875. Except in the three Scandinavian states and the kingdom of Saxony, where there seems to have been a slight temporary decline, the table shows a progressive increase, and in all cases, except the four mentioned, the number of suicides is greatest for the last period, 1871–'75. Such statistics as Professor Morselli has been able to collect since 1875 show continued "enormous aggravations," particularly in Denmark, Finland, England, Belgium, France, Bavaria, the kingdom of Saxony, Prussia, Germany, Austria, Galicia, and Bukowina, the cantons of Neufchâtel and Geneva, and Italy. A comparison of the number of suicides in the latest period with the number at earlier periods shows an increase of 183 per cent. in Sweden since 1816; of 57·7 per cent. in England since 1836; of 322 per cent. in Prussia since 1816; of 308·8 per cent. in Austria since 1821; of 651·9 per cent. in Galicia and Bukowina since 1821; and a greater or less percentage of increase in other countries. A part of the increase is doubtless only apparent, and due to the greater perfection of the later statistical reports, but a great real increase remains to be accounted for. Professor Morselli arranges the influences which may predispose to suicides under the heads of cosmic and natural, ethnic, social, and individual. In the first class, climate, technical conditions, the phases of the moon, days, and hours, exert no perceptible influence, but an increase of suicides seems to accompany the monthly rise of temperature. The influence of race is not well defined, except, perhaps, feebly in the Germanic race. As for social influences, the inclination to suicide does not appear to be determined by the degree of civilization or of general instruction, by moral conditions (as to the prevalence of crime and natural births), nor by political and economical conditions. As for religion, Protestants seem as yet to kill themselves oftener than Roman Catholics, and still more frequently than Jews, in the countries where the three religions are represented in proportions of any importance. Density of population is without appreciable effect; but suicide is more frequent in cities than in the country. So far as individual influences are concerned, women kill themselves three or four times less frequently than do men; suicide increases with age to the extreme limit of life; marriage exerts a very marked preventive effect, while celibacy and widowhood favor suicide. Inquiries into the motives for suicide have not brought satisfactory answers, for it is hard to get the truth told about them, and official reports must be accepted with reserve. In France, higher, more generous motives are attributed to women than to men.

Mr. John Gould.—Mr. John Gould, F. R. S., an eminent British ornithologist, who died early in February, was born in September, 1804. The appointment of his father, as a foreman in the Royal Gardens at Windsor, gave him an opportunity of beginning the preparation for the work of his life by studying British birds in a state of nature. In 1827 he was appoint Curator to the Museum of the Zoological Society in London. Here he published, under the title of "A Century of

Birds from the Himalaya Mountains," the figures of a small collection of birds which were then rare and little known in Great Britain. He then undertook the "Birds of Europe," on a similar plan, which was finished, in five large folio volumes, in 1837. In 1838 he made extensive journeys in Australia and the neighboring islands, and collected specimens for the "Birds of Australia," a work which he gave to the public in seven folio volumes, in 1848, and which contained much that was new on the range and habits of sea-birds. The "Birds of Asia," "Mammals of Australia," and "Birds of Great Britain," which followed, were on the same comprehensive plan, and revealed the same thoroughness of preparation and accuracy in the representation of typical specimens as the previous works. Besides these great undertakings, Mr. Gould was the author of monographs on the toucans, the trogons, the humming-birds, the ant-thrushes of the Old World, the partridges of America, and the birds collected during the voyage of the Beagle by Mr. Darwin, for all of which, as well as for the larger works, he prepared the original designs, from which the splendid colored plates—constituting "the most beautiful series of pictures of animal life which have yet been produced"—were executed.

The New Mineral, Peckhamite.—Professor J. Lawrence Smith has found a new meteoric mineral in the analysis of the great meteorite which fell in Emmett County, Iowa, in May, 1879, and has named it Peckhamite. He describes it as decidedly different from any mineral he has seen associated with meteorites. It is a silicate of iron and magnesia, opalescent, of a light greenish-yellow color, of greasy aspect, and cleaves readily. In two or three specimens the mineral projected from the outer surface of the stone, with a dingy-yellow color and a fused exterior. It differs widely in structure from olivine, which was abundant in the stone. Professor Smith states, as an additional fact concerning the meteorite, that its fall was attended by a shower of fragments like hailstones, of which several thousand, varying from the size of a pea to five hundred grammes in weight, have been picked up. All the smaller pieces are lumps of nickeliferous iron, and even the larger ones have but little stony material attached. They lay on the wet prairie for nearly a year, and are yet not at all rusted; many parts are still bright, and some look like nuggets of platinum.

Quarantine and Systematic Medical Inspection.—The "Lancet" denies that there is any value in the ordinary practice of quarantine. The reasoning on which the system is founded is plausible and seductive, but it is impossible to make it practically efficient. Contraband—the secret escape of infected persons and goods through the lines—is one of its commonest accompaniments, and most often defeats its purpose. "Moreover, in all great extensions of disease, the initial extension has generally occurred before the danger was anticipated, and the imposition of quarantine has taken place after the mischief which it was designed to avert had been accomplished." Quarantine is generally credited with having prevented the extension of the recent plague from the Volga to Europe, but wrongly; though enforced, it did not prevent the conveyance of the pest from Persia to Russia; and it had no effect upon the transmission of the disease from the Volga, for the plague had practically ceased to prevail before any measure of quarantine was adopted. It has been, in fact, an evil, both on account of its futility and because it has diverted attention from a true means of preventing infectious disease. "In so far as it may have contributed to a clearer knowledge of the conditions under which the isolation of persons and things is desirable and may be advantageous, and of the hygiene of ships and of masses of persons, such as pilgrims and emigrants, journeying both by sea and by land, quarantine may indirectly have yielded certain advantages, but advantages wholly disproportionate to the cost at which they have been gained, and which were attainable in a much simpler and more effective fashion." England and Denmark have ceased to rely upon quarantine as a protection against infection, though they still keep up the forms in order to obviate disabilities that would be imposed on their shipping by other governments which adhere to the practice. The system of medical inspection

and the general sanitary administration take its place in England. The sanitary administration is so devised that every district, whether inland or on the coast, is enabled to deal with infectious disease, coming from whatever source, in the most efficacious manner. The sanitary authorities of the ports are, moreover, given power to inspect medically persons arriving in ships from infected places, remove and isolate the sick, and use whatever processes of disinfection may be deemed necessary. Experience has shown that this system "does all that the most efficient quarantine can be hoped to do, and that more effectually, without involving those grave hardships to individuals and interruptions and disturbances to commerce which have arisen and must arise from quarantine."

Retreat of Glaciers.—M. Charles Dufour read a paper on the retreat of glaciers, at the recent meeting of the French Association for the Advancement of Science. His observations of the phenomena were begun in 1870, while he was sojourning by the glacier of the Rhône for the purpose of measuring the amount of the condensation of vapor on the ice. In connection with Professor Forel, he made a chart of the front of the glacier, as it was defined by reference to marks fixed in the moraine. The comparisons for the revision of the chart from year to year established the fact that the glacier was constantly receding. According to the statements of the inhabitants of the country, the retreat began in 1855 or 1856, and it now exceeds all that has been otherwise certainly determined within historical times. This phenomenon is not peculiar to the glacier of the Rhône. All of the glaciers of the Alps have begun to recede at some time more or less distant, and some of them have even disappeared. The same is the case with the glaciers of the Pyrenees and the Caucasus. Information is still wanting with reference to the glaciers of the Scandinavian Alps. A general retreat of so much importance as appears to be shown can hardly be explained by a theory of casual modifications of climate.

American Storms in Europe.—M. Hébert communicated to the French Association for the Advancement of Science the results of an investigation which he had made, day by day, during six months of winter, of the meteorological phenomena of North America from Greenland to Colombia and Venezuela. He traced the formation, along the grand mountainous crest of the continent and on its eastern slope, of powerful phenomena of sirocco, which dried the continent and limited its vegetation. He followed the rotatory storms which are produced on these crests step by step across the continent and the adjacent seas and to the western coasts of Europe. These storms, which are much more powerful than those which he has investigated in Europe, have otherwise, but with much more intensity, the same characters with them, and are the source of the depressions and tempests which are experienced in Europe. The storms which reach the European coast originate for the most part in Mexico, Central America, and the northern parts of South America; but they do not generally strike the Atlantic till after they have traversed a more or less extended part of the length of the North American Continent. The storms which originate in the United States reach Greenland, or pass the neighborhood of Iceland or the Faroe Islands, too far away to affect Europe.

Carbonic Acid in the Sea.—In communicating his studies on the proportion of carbonic acid in the air, M. Schloesing remarks that some of the causes which regulate the production and consumption of this substance are subject to considerable and relatively rapid variations; such are vegetation and the slow combustion of organic residua, the activity of which depends on the temperature. But, besides the fact that these variations take place in an inverse degree in the different regions of the globe, and therefore partly balance one another, there exists a powerful regulator of them, which combines its action with that of the circulation and the commingling operation of the atmosphere: it is the sea. Acting upon this idea, M. Schloesing has calculated the quantity of carbonic acid concealed in the seas, and has arrived at the conclusion that the sea holds in reserve a quantity of acid available for exchange with the atmosphere ten times greater than the whole quantity

contained in the atmosphere, and, *a fortiori*, much greater than the variations in that quantity. Although the figures can not be absolutely correct, we may certainly conclude that the sea is much richer in disposable carbonic acid than the atmosphere, and is in good condition to play the part of a regulator of the supply.

NOTES.

A TWO months' course of instruction in plumbing and sanitary engineering was opened on the 16th of February, in connection with the Technical Schools of the Metropolitan Museum of Art in this city. The lectures on the chemical side of the course are delivered by Professor C. F. Chandler, those on plumbling by Mr. C. F. Wingate. The enrollment at the earlier meetings of the class was unexpectedly large, and indicated the existence of a lively and wholesome interest in the subject.

SEVERAL papers of much interest were read at the second annual meeting of the Natural History Society of Illinois, held February 8th. Professor S. A. Forbes discussed the "Illustrations and Applications of Evolution," with especial reference to the restocking of our waters with their native species of fish. He showed that the idea that fishes could be artificially multiplied in such numbers that it would make no difference how, or where, or in what numbers they were caught, involved a contradiction of the doctrine of natural selection. The food-supply of fishes was diminished by the drainage of swamps, the restriction of overflows by levees, and by other operations attendant upon the settlement of a country; and it was not to be expected that the fishes in a body of water could be permanently kept up to as high a number as flourished before the natural conditions were changed.

STEPS have been taken in this city to provide the necessary organizations to furnish facilities for cremation. A draft of a charter has been approved by the persons concerned in the movement, for the formation of "the United States Cremation Company (limited)," with a capital of fifty thousand dollars, whose peculiar object shall be "to cremate the human dead in the quickest, best, and most economical manner." A plan has also been adopted for the formation of the "New York Cremation Society," as an association distinct from the purely business enterprise, having for its object "to disseminate sound and enlightened views respecting incineration as preferable to burial, and to advance the public good by offering facilities for cremation."

PROFESSOR DR. EMANUEL BORICKY, a Bohemian mineralogist, who died January 27th, aged forty years, was best known by his microscopical researches in petrography. He had been connected with the Bohemian Museum and the University and colleges of Prague since 1865, and since 1871 had lectured in the Bohemian language on petrography at the University of Prague. He has left a monograph on the porphyries ready for the press.

MR. WILLIAM P. BLAKE describes, in the March number of the "American Journal of Science," the beds of realgar and orpiment in the sedimentary formations underlying the lava in Iron County, Utah. These arsenical sulphides are found in lenticular and nodular masses, in a layer about two inches thick, in a compact, sandy clay. Above and below the layer and close to it are thin parallel seams of fibrous gypsum, while the strata above, for thirty feet or more, are arenaceous clays charged with soluble salts which exude and effloresce, forming hard crusts. The whole appearance and association of the minerals indicate that they have been formed by aqueous infiltration since the deposition of the beds. Beds of stibnite, or antimony sulphide, in the same formation, had probably a similar origin.

CHARLES F. KUHLMANN, a distinguished Alsatian chemist and economist, whose death has recently been announced, had been for the last forty years a prominent figure in the industrial and scientific circles of France, and was known as the founder at Lille of one of the most important chemical manufactories of the world. His name is also associated with investigations which have had valuable results on the baryta compounds, the crystallization of insoluble bodies, on the manufacture of sugar, on the chemistry of mortars and manures, bleaching, dyeing, and printing, and on many subjects of a more purely scientific character. His collected researches were published in 1879 in a single large volume.

MERCADIER has described a new and economical method of producing intermittent luminous signals by burning petroleum with oxygen. He has a lamp with a round wick, within which is a tube rising not quite up to the level of the top of the wick. This tube reaches a reservoir of oxygen: when the lamp is lighted and a properly adjusted jet of oxygen is permitted to reach it, it gives out a white flame, the intensity of which approaches that of the oxyhydrogen light. When the lamp is burned without oxygen, it gives a smoky flame of little brilliancy, which will, however, rapidly increase in intensity, and soon reach a maximum when the oxygen is turned on.

M. PASTEUR has reported concerning experiments on the endurance of vitality in the germs of disease. Seven sheep were led daily, for a few hours, to a piece of ground where some animals that had died of anthracoid disease, or *charbon*, had been buried twelve years previously. Two of the sheep caught the disease and died. As there was no grass on the spot for the animals to eat, M. Pasteur believes that they must have received the germs of the malady from smelling about the ground, as sheep are in the habit of doing.

MR. WILLIAM WHITE, author of several works on subjects of chemistry and mining, died in London, January 29th, at the age of seventy-one. He had held at different periods lectureships on metallurgy and chemistry at various educational establishments, and had been a constant contributor to scientific literature for more than half a century.

THE council of the Society of Arts has offered for its third Congress on Domestic Economy, which is to be held during the present year, prizes for papers not exceeding one thousand words each, written by teachers, and giving accounts of the best methods practiced by them, of their experience, and of the results of their teaching on the subjects of clothing and washing; the dwelling—warming, cleaning, and ventilation; rules for health, including the management of the sick-room, cottage income, expenditure, and savings; food, its composition and nutritive value, its functions, its preparation and culinary treatment. The papers are to be sent in to the secretary of the Society, London, by the first of May next.

A COURSE of twenty-five lectures, for practical instruction in invertebrate paleontology, was opened in Philadelphia, March 8th, by Professor Angelo Heilprin, under the auspices of the Academy of Natural Sciences of that city. The plan of instruction embraces the examination of the life-histories of the various geological formations, the discussion of the biological relations of past organic forms, and the practical determination of those forms for the purposes of paleontological inquiry. A course of ten lectures for practical instruction in determinative mineralogy was begun by Professor H. Carvill Lewis, March 15th.

WHALES were formerly counted as important aids to the fisheries of the North Sea coasts, by driving immense numbers of small fishes toward the land. Now, according to M. Bogdanoff, of the recent Russian North Sea expedition, since the whales have been pursued with steamers and bullets instead of sailing-vessels and the old harpoon, their destruction has greatly increased, and the number of small fish coming to the coast has correspondingly diminished. The cod-fishing has been nearly extinguished in parts of the Varanger Fiord region in consequence of the presence of sharks, which, attracted by the fat thrown into the sea at Varanger, destroy the fish. Both of these instances illustrate the interdependence which exists among the different kinds of animals inhabiting the same region.

PROFESSOR DU BOIS-REYMOND, in conjunction with Professor G. Fritsch, is about to publish, under the auspices of the Royal Academy of Sciences at Berlin, the observations and experiments made by the late Dr. Karl Sachs on the electrical eel (*Gymnotus electricus*), in South America, during 1876 and 1877.

M. GRÉHAUT has been endeavoring to determine by experiment what proportion of carbonic oxide in the atmosphere is necessary as a minimum to produce the death of animals. With a dog the proportion varied from $\frac{1}{250}$ to $\frac{1}{200}$; a hare was not asphyxiated till it had been exposed to an atmosphere containing $\frac{1}{60}$ of carbonic oxide; a sparrow was killed by confinement in an atmosphere charged with only $\frac{1}{250}$ of the gas. A very wide range of difference is thus shown to exist in the susceptibility of different species to this poison.

PROFESSOR ADOLPHE BRONGNIART was engaged at the time of his death in the study of the silicified seeds of the carboniferous beds of St. Etienne and Autun, France. His investigations have been published by some of his family. Among the results was the discovery in fossil seeds of a pollen-bearing chamber hitherto unknown in any living plant, in which the pollen was held in reserve till the time of fecundation. M. Brongniart, remarking that the palæozoic plants exhibiting this disposition were related to the cycades, believed that the modern cycas might also possess it, and found his belief confirmed by an examination of plants of that genus. This is said to be the first time that paleontological studies have led to an anatomical discovery in living beings.

DR. JOHN JEREMIAH BIGSBY, F. R. S., a well-known writer on palæozoic fossils, died in London, February 10th, at the advanced age of eighty-eight years. The greater part of his life was spent in Canada and the United States. He contributed a paper on a subject of American geology to "Silliman's Journal," as far back as 1820. His best-known works are two "Thesauri," relating to the flora and fauna of the Silurian and the Devonian and Carboniferous formations, which were published in 1868 and 1878. He was the founder of the Bigsby medal, which is awarded at the annual meetings of the Geological Society of London.

INDEX.

PAGE

Accomplishments, The Value of ... 496
Adams, C. K ... 123
Æsthetic Evolution in Man ... 339
Africa, Eastern, Mr. Thomson's Journey in ... 856
Africans, Craniology of the ... 429
Allen, Professor Grant ... 339
American Institute Fair, The ... 127
Animals or Plants? ... 430
Animals, The Sense of Direction in ... 122
Antarctic Expedition, An ... 431
Anthropological Society, The German ... 425
Ants, About ... 696
Apes, Young, Studies of ... 426
Appleton, Thomas G ... 539
Arctic Journey, Lieutenant Schwatka's ... 277
Art, Evolution and Originality in ... 697
Association, The French ... 141
Asteroids, The, and Jupiter ... 715
Attention, Expectant, in Animals ... 285
Aubrey-Vitet, M. E ... 806
Automatic Brake, The Westinghouse ... 140

Barbarism, Lingering ... 638
Barton, Bolling W., M. D ... 262
Beard, George M., M. D ... 170
Binding, Deterioration of, in Libraries ... 718
Birds, English and American ... 142
Birds, Singular Powers in ... 853
Bolton, Professor H. Carrington, Ph. D ... 191
Bone-Caves in Pennsylvania ... 707
Books noticed:
"Two Worlds are Ours" (Macmillan) ... 129
"A True Republic" (Stickney) ... 129
"An Elementary Text-Book of Botany" (Prantl and Vines) ... 132
"Contributions to the Archæology of Missouri" ... 133
"Life on the Seashore" (Emerton) ... 133
"Introduction to the Mortuary Customs among the North American Indians" (Yarrow) ... 133
"Annals of the Astronomical Observatory of Harvard College" (Pickering, Searle, and Upton) ... 134
"The Hair, its Growth, Care, Diseases, and Treatment" (Leonard) ... 134
"Essays on Art and Archæology" (Newton) ... 134

Books noticed:

PAGE
"Qualitative Chemical Analysis" (Douglass and Prescott)..... 135
"Some Thoughts concerning Education" (Locke)..... 135
"The New Text-Book of Physics" (Cooley)..... 135
"Eminent Israelites of the Nineteenth Century" (Morais)..... 136
"Manual of Hydraulic Mining" (Van Wagenen)..... 136
"Deep-Sea Sounding and Dredging" (Sigsbee)..... 136
"Odontornithes" (Marsh)..... 270
"German Thought" (Hillebrand)..... 272
"The Elementary Principles of Scientific Agriculture" (Lupton)..... 273
"Summer-Land Sketches" (Oswald)..... 274
"An Elementary Treatise on Analytical Geometry" (Bowser)..... 275
"The Minor Arts" (Leland)..... 275
"The Textile Record of America" (Nagle and Ryckman)..... 276
"Diseases of the Throat and Nose" (Mackenzie)..... 276
"Memoirs of the Science Department, University of Tokio, Japan" (Mendenhall)..... 276
"The Atomic Theory" (Wurtz)..... 418
"The Skin in Health and Disease" (Bulkley)..... 420
"A Text-Book of the Physiological Chemistry of the Animal Body" (Gamgee)..... 421
"A Physical Treatise on Electricity and Magnetism" (Gordon)..... 421
"School and Industrial Hygiene" (Lincoln)..... 422
"The Ocean as a Health-Resort" (Wilson)..... 423
"The Philosophy of Mathematics" (Bledsoe)..... 423
"The Orthoëpist" (Ayres)..... 423
"What to do first in Accidents or Poisoning" (Dallas)..... 424
"Scotch Sermons"..... 559
"Modern Thinkers" (Denslow and Ingersoll)..... 562
"The Scientific Basis of Spiritualism" (Sargent)..... 564
"Progress and Poverty" (George)..... 564
"Medical Heresies historically considered" (Smythe)..... 565
"Passages from the Prose Writings of Matthew Arnold"..... 565
"The Journal of Physiology" (Foster)..... 565
"The Beautiful and the Sublime" (Kedney)..... 566
"A New School Physiology" (Dunglison)..... 566
"Diphtheria: Its Cause, Nature, and Treatment" (Gregg)..... 566
"Animal Life as affected by the Natural Conditions of Existence" (Semper)..... 698
"Annual Report of the Chief of Engineers, United States Army"..... 701
"Life and her Children" (Buckley)..... 701
"Transcendental Physics" (Zöllner and Massey)..... 702
"Consumption, and how to prevent it" (Mays)..... 703
"British Thought and Thinkers" (Morris)..... 703
"Elementary Projection-Drawing" (Warren)..... 704
"Practical Plane Geometry and Projection" (Angel)..... 704
"The Publishers' Trade-List Annual, 1880"..... 704
"The Geology of Hudson County, New Jersey" (Russell)..... 704
"An Elementary Course of Geometrical Drawing" (Vose)..... 705
"Among Machines"..... 705
"Telegraphic Determination of Longitudes on the East Coast of South America" (Green, Davis, and Norris)..... 705

Books noticed: PAGE
"The Relations of Science to Modern Life" (Potter)..... 705
"Learning to Draw" (Viollet-le-Duc)..... 706
"A Text-Book of Elementary Mechanics" (Dana)..... 706
"Summary of Substantialism" (Story)..... 706
"The Feeling of Effort" (James)..... 706
"Food for Invalids" (Fothergill & Wood)..... 843
"Study of Indian Languages" (Powell)..... 844
"Geology of the High Plateaus of Utah" (Dutton)..... 844
"The Power of Movement in Plants" (Darwin)..... 845
"The Study of Political Economy" (Cossa)..... 848
"Young Folks' Cyclopædia of Persons and Places" (Champlin)..... 848
"James Smithson and his Bequest" (Rhees)..... 848
"Culture of the Sugar-Beet" (McMurtrie)..... 849
"Sanskrit and its Kindred Literatures" (Poor)..... 849
"High Schools" (Northrop)..... 849
"Geological and Natural History of Minnesota"..... 850
"Noxious and Beneficial Insects of Illinois" (Thomas)..... 850
"Abridgment of the Nautical Almanac for 1881"..... 850
Breath, Temperature of the..... 708
British Association, The Fiftieth Meeting of the..... 138
Brunton, T. Lauder, M. D., F. R. S..... 226, 374
Buckland, Mr. Frank..... 812
Buckley, Arabella B..... 96
Burglar-Alarm, The Electric..... 56
Burns, Professor E. S..... 760

Calvin, S..... 610
Carhart, Professor H. A..... 513
Caribbean Sea, The Deep Valley of the..... 287
Caves in Japan..... 143
Cerebral Localization..... 599
Chahoon, George..... 122
Change as a Mental Restorative..... 285
Chasles, Michel, Sketch of..... 840
Chemical Affinity, A New Theory of..... 717
Chemical Elements, Evolution of the..... 526
Chronology, History of..... 760
Clarke, Professor F. W..... 337
Climatology of Europe..... 716
Coal, A Piece of..... 610
Consumption and Climates..... 284
Coral, Rate of Growth of..... 719
Correspondence..... 122, 262, 696
Cox, Sir George W..... 468
Crane, Professor T. F..... 824
Criticisms Corrected. (Herbert Spencer)..... 101, 387
Crust of the Earth, M. Faye's Theory of the..... 574
Cyclone, A Miniature..... 264

Death, Distinctions between Real and Apparent..... 401
De Costa, B. F..... 31

PAGE
Deep-Sea Animals, Sensitive Organs of..... 575
Demagogues, Powder and Ball for..... 128
Denning, W. F..... 178
Disease, Do Stenches cause?..... 856
Dumas, Sketch of Professor..... 257
Dust, A Shower of..... 263

Earthquakes, M. Delaunay's Theory of..... 855
Eddy, William A..... 496
Editor's Table..... 125, 265, 412, 553, 697
Educational Logic, Curious..... 267
Education as a Hindrance to Manual Occupations..... 26
Education, Mixed..... 719
Education, Physical..... 303, 456, 577, 753
Eel, Structural Peculiarities of the..... 569
Electricity, Atmospheric..... 513
Electric Light, The Diffusion and Softening of the..... 715
Electric Light, the Maxim..... 424
Electro-Motors and Dynamo-Machines, Improvements in..... 280
Elevators, Improved Safety Construction of..... 137
Europe, American Storms in..... 862

Facts, Mr. Herbert Spencer's..... 263
Faraday, Henry and..... 76
Farquhar, W. H..... 264
Field-Naturalists' Club, A..... 415
Fisher, L. C..... 696
Fishes, The Migrations of..... 212
Folk-Lore, Plantation..... 824
France, Infertility in..... 859
Fraser, Dr. William..... 401
Fruit, The Stone-Grains in..... 428

Galton, Francis, F. R. S..... 64
Gardner, W. H., M. D..... 43
Geikie, Professor Archibald, F. R. S..... 654
Glacial Man, The, in America..... 31
Glaciers, Retreat of..... 862
Gould, Mr. John..... 860
Grate, An Improved Smokeless..... 854
Gravels, Trenton, The Age of the..... 567
Greek, The Study of, at Cambridge..... 412

Hallowell, H. C..... 264
Harmond, Dr. J..... 384
Haviland, Charles T..... 681
Hawkins, John..... 696
Heat in Tunnel-Excavations..... 713
Heat, The Sun's..... 11
Heidenhain, Dr. R..... 362

PAGE

Heincke, Dr. Friedrich 212
Henry and Faraday 76
Hofmann, A. W 257
Horses and their Feet 468
Huxley, Professor T. H., F. R. S 159
Hypnotism 108
Hypnotism, Artificial 362
Hystero-Demonomania, An Epidemic of 851

Ignorance, The Advantages of 337
Imagery, Mental 64
Indigestion as a Cause of Nervous Depression 226, 374
Indigo, The Manufacture of, in Bengal 708
Industrial Education, Methods in 202
Insect Conservatism, Lubbock on 396

Johnston-Lavis, H. J., F. G. S 776
"Jumpers" of Maine, Experiments with the 170

Kirkwood, Professor Daniel 542

Lassell, William (obit.) 716
Laveleye, Emile de 669
Lead Pipes, Perforation of, by Rats 708
Lead Pipes, Rats and 429
Liability, Some Notes on a Doctor's 769
Life, The Profusion of 96
Lightning-Rod, Form of the 572
Lights, Artificial 283
Literary Notices 129, 270, 418, 559, 698, 843
Lubbock on Insect Conservatism 396
Lungren, Charles M 217, 323, 483
Luxury, The Morals of 669
Lyman, Oliver E 769
Lyons, P. F 263

Man and the Vertebrate Series 783
Man, Æsthetic Evolution in 339
Married Women, The Legal Position of 643
Marshall-Islanders, The 278
Mayer, Professor Alfred M 76
McCosh, James 122
Mendenhall, Professor T. C 356
Meteor, A Brilliant 696
Meteoric Stones, The Markings of 282
Meteors, The August 178
Meteors, The November 542
Millikin, Dan 262
Mimicry, Protective, A Case of 262
Mind as a Measure of Nature 681
Mind in Work 709

PAGE
Minerals, Artificial Production of 857
Miners, Diseases of 717
Mining, Prehistoric, in North Carolina 568
Mirage, The, on Swiss Lakes 286
Monday-Lectureship Philosophy 556
Moon, Changes on the 710
Morgan, Lewis H., Sketch of 114
Morris, Charles 80, 783
Motion, Optical Illusions of 519
Motors, Domestic (C. M. Lungren) 217, 323, 483
Muscle, Mode of Termination of Nerves in 853
Musical Valley, A 429
Music, Oriental 237
Myer, Albert J., Sketch of 408
Mythological Crows, A Flock of 43

Naturalists, The Felicity of 821
Notes 143, 287, 431, 575, 719, 863
Nuisances, Municipal, The Problem of 585

Ocean-Currents, The, of Greenland and Iceland 710
Oceanica, The Black Races of 744
Ocean, Variability of the Level of the 718
Oil-Plants of French Guiana 384
Organic Form, The Evolution of 80
Oswald, Felix L., M. D 303, 456, 577, 753
Oysters, The Green Color of 855

Parsons, Samuel, Jr 797
Pearce, S. Austen, Mus. Doc., Oxon 237
Peckhamite, The New Mineral 861
Peirce, Professor Benjamin, Sketch of 691
Photography, Progress in 570
Physical Education (Oswald) 303, 456, 577, 753
Physical Education (Editor) 418
Plants, Darwin on the Movements of 498
Plants, the Relative Hardiness of 797
Plow and Wheel-Carriage, Origin of the (Tylor) 448
Pneumonia, Elevator 854
Political Institutions, The Development of (H. Spencer). 1, 145, 289, 433, 624, 721
Political Science 125
Popular Miscellany 137, 277, 424, 567, 707, 851
Pottery, Types of 138
Pourtales, Count, Sketch of 549
Powell, J. W 114
Progress, Human, The Forces of 553
Publications Received 137, 276, 424, 566, 707, 850

Quarantine, and Systematic Medical Inspection 861

Rainfall, Relation of Elevation and Exposure to 714
Reading, What the Eye sees in 262

PAGE

Respiration, Effect of Physical Training on 284
River-Water, Purification of, by Organic Agents 709
Rock-Weathering, as Illustrated in Churchyards 654
Romanes, George J. 108

Sabbath, The (J. Tyndall) 246, 310
Sanitary Improvement, Efficacy of 430
Science and Culture 159
Science at Princeton College 122
Science at the University of Michigan 123
Science in the Colleges 126
Science College, Sir Josiah Mason's 265
Science in the Schools of France 573
Science, Prehistoric, en Fête 544
Sciences, The National Academy of 412
Scientist, An Ancient 833
Sea, Carbonic Acid in the 862
Sea, The Deep Explorations of, off the Coast of France 855
Seguin, Dr. Edouard 268
Sewerage, The Study of, in London 414
Sewer-Waters, The Purification of 806
Smelting-Furnace, A New 281
Spencer, Herbert 1, 101, 145, 289, 387, 433, 624, 721
Spencer, Mrs. A. G. 643
Solar Machine, A 283
Solar System, M. Faye's Theory of the 858
Spiders and Tuning-Forks 718
Split Stones in the Desert 569
Stammering 711
State, The, as an Educator 664
Strawberry-Leaf Beetle, The 852
Suicide, Relation of Age and Marriage to 282
Suicide, Statistics of 860

Thermometers, Examination of, at the Yale Observatory 367
Thermometers, Variations in the Fixed Points of 286
Thompson, Professor Silvanus P. 26, 202, 519
Thunderstorms, The Phenomena of 572
Tracy, R. S., M. D. 585
Transformation of Sound into Light 142
Trees, The Circulation of Sap in 140
Trichinosis on a British School-ship 574
Turquoises 712
Tylor, E. B. 448
Tyndall, Professor John, F. R. S. 246, 310
Typhoon, A Japanese 356

Varigny, Henry de 599
Vernean, Dr. R. 744
Vine-Slip, Only a 539
Visual Tests, The Regulation of 571

PAGE
Vogt, Carl..... 638
Volcanic Cones, Origin and Structure of..... 776

Waldo, Dr. Leonard..... 367
Walpole, Spencer..... 812
Ward, Lester F..... 526
Water-Plants, Variations in the Forms of..... 570
Wilson, H. H..... 664
Women, The Early Practice of Medicine by..... 191

Yellowstone, The Great Glacier of the..... 568
Youmans, Eliza A..... 498
Young, Professor C. A..... 11

END OF VOL. XVIII.